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ARCADIS Design & Consultancy for natural and built assets

Blue Tee Corp.

DRAFT FINAL DESIGN REPORT

Remedial Design
Old American Zinc Plant Site
Fairmont City, Illinois

March 2016

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ACRONYMS AND ABBREVIATIONS

AOC	Administrative Order on Consent
ASTM	American Standards for Testing Materials
ARAR	Applicable and Reasonable Appropriate Requirements
AFTL	ARCADIS Field Team Leader
ASTM	American Standards for Testing Materials
BHHRA	Baseline Human Health Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
COC	Chain of Custody
COPEC	Constituents of Potential Environmental Concern
CLP	Contract Laboratory Program
DFDR	Draft Final Design Report
DQO	Data Quality Objective
EFTL	ENTACT Field Team Leader
FSP	Field Sampling Plan
FTL	Field Team Leader
HASP	Health and Safety Plan
IC	Institutional Control
ICIAP	Institutional Control Implementation and Assurance Plan
IEPA	Illinois Environmental Protection Agency
ISA	Integrated Site Assessment
LQM	Laboratory Quality Manual
MS/MSD	Matrix Spike/ Matrix Spike Duplicate
mg/kg	Milligrams per kilograms
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbons
PARCC	Precision, Accuracy, Representativeness, Completeness, Comparability
PPE	Personal Protective Equipment

PCBs	Polychlorinated Biphenyls
PDI	Pre-Design Investigation
PDIR	Pre-Design Investigation Report
DFDR	Preliminary Design Report
PID	Photo-ionization Detector
RPM	Remedial Project Manager
QA	Quality Assurance
QA/QC	Quality Assurance/ Quality Control
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
RA	Remedial Action
RAO	Remedial Action Objective
RD	Remedial Design
DFDR	Preliminary Design Report
RDWP	Remedial Design Work Plan
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPD	Relative Percent Differences
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/ Feasibility Study
RPM	Remedial Project Manager
SMC	Sample Management Coordinator
SOP	Standard Operating Procedure
SOW	Statement of Work
SPLP	Synthetic Precipitation Leaching Procedure
SRM	Standard Reference Materials
SSO	Site Safety Officer
SSP	Support Sampling Plan
STL	Severn Trent Laboratory
SVOC	Semi Volatile organic Compounds
SW846	Test Methods for Evaluating Solid Waste 1986.

TAL	Target Analyte List
TAT	Turn-Around-Time
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TCRA	Time-Critical Remedial Action
TPM	Technical Project Manager
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
XRF	X-Ray Fluorescence

1 INTRODUCTION

This Draft Final Design Report (DFDR) for the Remedial Design (RD) for the Old American Zinc Plant Superfund Site (the Site) in Fairmont City, Illinois has been prepared by ARCADIS U.S. Inc. (ARCADIS) on behalf of Blue Tee Corp. (Blue Tee). This DFDR is being submitted in accordance with the Administrative Order on Consent (AOC) and Settlement Agreement for Remedial Design (CERCLA Docket No. V-W-14-C-011).

Remedial Investigation/Feasibility Study (RI/FS) activities were conducted at the Site from 2005 to 2012. The final RI Report was approved by the U.S. Environmental Protection Agency, Region 5 (USEPA) in April, 2009 and the final FS Report was approved by USEPA in March, 2012. The USEPA issued a Record of Decision (ROD) for the remediation of the Site on September 11, 2012. The final RD Work Plan was approved by USEPA on May 12, 2015. The Preliminary Design Report was submitted in December 2015.

1.1 Purpose

The DFDR is intended to summarize the draft final RD for the Site as described in the ROD and the August 2014 AOC.

As required by the AOC and discussed in the RD Work Plan, this DFDR includes:

- Results of any completed pre-design investigation and/or additional field sampling and analysis (Section 3.1);
- Design of the consolidation area including: location and configuration of the consolidation area, required site preparation activities, design assumptions, parameters and supporting design calculations (Sections 4.3.4 and 4.3.6 – 4.3.8);
- Design for ditches and drainages to be remediated or created as part of the remedial action (Section 4.3.3 and 4.3.7);
- Post-remedial topography and drainage plan for the remediated areas of the Facility Area (Section 4.3.5);
- Description of the RA approach to address identified affected properties located off of the Facility Area (Section 4.3.2);
- Any other relevant preliminary plans, drawings, sketches, and design calculations not listed specifically above, but required for this project;
- Volume of material by type to be excavated and transported to the Consolidation Area (Section 4.3.8);
- Volume of material to be transported to off-Site disposal facilities (Section 4.3.8.1);
- Volume and specifications of required borrow materials (Section 4.3.8.2);
- Easements and substantive permit equivalency requirements (Section 4.3.9); and

- Preliminary construction schedule, including the selection of the remedial action contractor (Section 4.3.10); and
- A discussion of how the RD complies with the Applicable or Relevant and Appropriate Requirements (Section 4.3.11).
- Additional Details in response to comments on the PDR (Various Sections and Appendix D)
- More detailed information on the design elements included in the PDR.
- Outlines for the RA Work Plan (RAWP), Health and Safety Plan (HSP), Quality Assurance Project Plan (QAPP), Institutional Controls Implementation and Assurance Plan (ICIAP), Operation and Maintenance Plan (O&MP)

2 SITE BACKGROUND

The Site is located in the Village of Fairmont City (Village), Illinois, and consists of an approximately 132-acre Facility Area where former zinc smelting operations were conducted, and areas surrounding the Facility Area where elevated concentrations of metals associated with the historic smelter operations were found in various media (collectively referred to as the Site). The approximate boundaries of the Facility Area and Site are shown on **Figure 1**. The boundary of the Facility Area is also shown on **Drawing 1** of the RD drawings in **Appendix A.** Specific areas of the Facility Area are shown on **Figure 2**.

The Site includes the following components:

- The Facility Area;
- Residential, commercial, and vacant properties around the Facility Area that have concentrations of contaminants of concern (COCs) above the applicable cleanup levels (CLs);
- Alleyways owned by the Village that have concentrations of COCs above the non-residential CLs;
- Drainage ways, including Rose Creek, the West Ditch and the West Ditch outfall, that have elevated concentrations of COCs from drainage from the Facility Area; and
- Shallow groundwater within and immediately adjacent to the Facility Area.

The area encompassing the Site lies within the Upper Alluvial Valley of the Mississippi River flood plain of the Springfield Plain Subdivision of the Till Plains Section of the Central Lowland Province. The general topography is relatively flat and is at a general elevation between 400 and 420 feet above mean sea level with a regional slope of 5 to 10 feet per mile to the southwest. A terrace slope generally running parallel and north of Collinsville Road separates the Upper Alluvial Valley, where the Facility Area is located, from the American Bottoms, a low elevation bottomland that covers approximately 175 square miles and is approximately 30 miles long and 11 miles across at its widest point.

A detailed Site history, including operations and early remedial actions, is presented in the RD Work Plan, as well as in other reports noted previously

2.1 Site Characterization

The Facility Area is an inactive approximately 132-acre parcel located in the southeast quarter of Section 4, Township 2 North, Range 9 West in St. Clair County, Illinois. The Facility Area is immediately bordered by commercial or industrial facilities to the south, west and east. The majority of the residential properties in the vicinity of the Facility Area are located to the west, with smaller pockets of residential or trailer park developments to the north, south and east. The Facility Area features are shown in **Figure 1**. The residential, commercial/industrial and vacant properties surrounding the Facility Area include properties which may have been affected by historic smelting operations primarily through the redistribution of slag used as fill or surfacing materials. A total of 462 residential, commercial and vacant properties located in Fairmont City and the adjacent community of Washington Park were sampled for lead, arsenic, cadmium and zinc as part of a 2002-2003 Time-Critical Removal Action (TCRA) conducted at the Site. An

additional 39 residential, commercial and vacant properties and eight alleyways were sampled as part of the RI and PDI. Based on this sampling a total of 77 properties and two alleyways have been identified to be addressed by the RA.

2.1.1 Groundwater and Hydrogeologic Conditions

Groundwater at the Site is encountered in the shallow aquifer, ranging from 13 to 75 feet bgs; within this range are two separate horizons. The saturated horizon from 0 to 30 feet bgs is considered to be non-potable groundwater (Illinois Class II groundwater), as determined by IEPA. Groundwater deeper than 30 feet bgs is considered potable water (Illinois Class I groundwater). These classifications are Site-specific due to the conditions at the Site. The State of Illinois has a Comprehensive State Groundwater Protection Program (CSGWPP) where the State can define a specific groundwater aquifer as non-potable and not a true drinking water aquifer. The IEPA determination for the Site can be found in the Administrative Record file.

Groundwater flow at the Site is toward the west-northwest.

2.1.2 Extent of Contamination

The RI identified COCs that pose potential risks to human health and/or the environment including arsenic, cadmium, lead, and zinc. The significant findings and conclusions from the Site characterization activities completed during the RI are discussed in detail in the RI and are briefly summarized below.

2.1.2.1 Source Materials

The RI determined that the primary source of COCs at the Site at levels in excess of the screening levels is slag which is present on the Facility Area both in localized stockpiles of vitrified slag material and ground granular slag material redistributed across the Facility Area as structural fill. The remaining volume of the surficial stockpiled slag is approximately 33,400 CY and encompasses approximately 4.3 acres. Granular slag was also identified in the RI beneath compacted gravel in alleyways, and in surrounding residential, commercial and vacant properties in the Village adjacent to the Site.

Several trenches were excavated across the footprints of former smelter structures to identify the nature and extent of material within the foundation/basement areas of the former structures. The majority of materials encountered in the trenches consisted primarily of slag fill, with buried demolition debris, including non-slag waste material, mixed with or under the granular fill. Non-slag waste materials included small localized instances of tar-like materials assumed to be residual products historically used at the Facility Area. The locations of the trenches are shown on **Figure 3**.

At present, the ground redistributed slag covers approximately 90 acres of the Facility Area, ranging in thickness from 6 inches to more than 10 feet, with an average depth of 3.5 feet and an approximate volume of 713,000 cubic yards (CY), calculated based on a comparison of a 3-dimensional surface of the base of source materials based on the thicknesses observed in borings and trenches to the existing topography. The approximate bottom of source material is presented on **Drawing 2 in Appendix A**. Estimated thicknesses of source material are presented on **Drawing 3** in **Appendix A**. In the low-lying, un-vegetated area in the northern portion of the Facility Area, the fill material consists of a dry, grey to black talc-like powder that reaches a thickness of 6 inches.

In some areas the surficial fill horizon includes demolition-type materials (i.e. bricks, gravel, concrete, wood, etc.) from the burial of demolition debris from the former smelter structures.

2.1.2.2 Soils

Soil samples were collected from residential, commercial industrial and vacant properties as part of the TCRA. Soil samples were also collected from within the Facility Area and the surrounding residential, commercial/industrial and vacant properties, as well as alleyways, as part of the RI. Soil samples from residential, vacant, and commercial/industrial properties with concentrations of COCs exceeding the CLs were typically found in areas where slag-like granular fill material had been deposited on the properties or the adjacent Village alleyways as fill or surfacing. The remaining elevated metal concentrations were believed to be associated with observed chipped paint, or abundant debris observed in some vacant properties located within Washington Park, as detailed in the TCRA and RI Reports. During the RI, it was determined that elevated concentrations of COCs in soil were found to not be a result of airborne deposition, because no regular pattern of exceedances was found.

The alleyway samples with exceedances of CLs were typically associated with slag-like granular fill materials used as fill or surfacing on the alleyways. The concentration of metals in the alleyways decreased rapidly in native soils below the identified slag fill.

Locations of the residential, commercial industrial and vacant properties and alleyways which will be subject to remediation are shown on **Figure 4**.

2.1.2.3 Sediments

Sediment samples were collected from the ephemeral drainage ditches and Rose Creek that drain the Facility Area, and drainage areas within the Old Cahokia Watershed that are hydraulically connected to the Facility Area.

The overall trend observed during the RI was that the highest concentrations of COCs were found in the ditches located on the Facility Area and in the segment of Rose Creek bordering and immediately downstream of the Facility Area, with concentration of COCs decreasing with distance downgradient of the Facility Area. The vertical extent of COCs was limited by the thickness of sediments, which generally did not exceed 6 inches.

2.2 Feasibility Study

Following completion of the RI, an FS for the Site was conducted. The results of the FS are documented in the February 6, 2012 Feasibility Study Document (Rev. 3). The FS was based on the findings of the previously completed RI and risk assessments.

2.3 Remedial Alternative

The USEPA selected Alternative 4A from the FS in the Record of Decision (ROD) for the Site. Alternative 4A includes:

- Excavation of vitrified slag, redistributed ground slag, and affected soils and sediments inside the Facility Area, then consolidation of these materials into a 35-acre Consolidation Area on the Facility Area.
- Removal of affected soils and sediments outside the Facility Area to be managed with consolidated media inside the 35-acre Consolidation Area.
- Capping of source material and affected media in the Consolidation Area with a 24-inch, low-permeability, compacted soil barrier layer with a hydraulic conductivity no greater than 1×10^{-7} cm/sec and a 12-inch vegetated layer cover system.
- Establishment of Institutional Controls (ICs) in accordance with the Illinois Uniform Environmental Covenants Act to achieve the following: **1)** prohibit future residential land use on the 35-acre Consolidation Area and select off-Site properties that are not likely to be used for future residential development; 2) control access to engineered components of the remedy and prohibit intrusive activities in capped areas to maintain the effectiveness of the cap; and 3) prohibit the installation of potable wells and use of shallow groundwater within the affected groundwater plume until all groundwater cleanup standards have been achieved to ensure long-term protection of human health.
- Establishment of drainage controls on manmade ditches draining the Facility Area.
- Performing stormwater and groundwater monitoring.
- Implementing long-term operation and maintenance (O&M) activities to maintain the integrity of the cover system and other components of the remedy.
- Establishment of a groundwater management zone pursuant to regulations in the Illinois Administrative Code related to Groundwater Quality (35 IAC, Subtitle F, Chapter I, Part 620).

3 PRE-DESIGN INVESTIGATION

The PDI was conducted June 1 through June 6, 2015, to collect the necessary additional data to design the USEPA selected remedy. The PDI was undertaken based on the USEPA approved RD Work Plan dated May, 2015.

3.1 Pre-Design Investigation Results

3.1.1 Trenching and Test Pit Investigation

During the investigation in the proposed Consolidation Area several void spaces were located and traced. Sub-grade void areas under concrete pads were identified, most of which were connected by utility conduits ranging in size from 4 to 6.5 feet wide x 4 feet thick. The fill material in the trenches completed within the footprints of former buildings consisted of predominantly slag, coke, bricks, wood, large concrete chunks, metal, glass, and other building debris. The fill material extended to depths ranging from 4 to 8 feet below current ground surface in the Excavation Area and from 1 to 5 feet below current ground surface in the Consolidation Area. Concrete slabs in the Excavation Area were uncovered at depths ranging from 1 to 7 feet below ground surface. .

3.1.2 Test Pit Investigation

Seven test pits were completed in the TCRA soil stockpile, the Excavation Area, and the Consolidation Area as part of the PDI. These test pits were completed in order to collect samples of materials for geotechnical and agronomic analysis.

Geotechnical samples were collected from trench TR-11 and test pits ETP-1, ETP-2, CPT-1 and CTP-2 (Figure 3) and submitted for geotechnical testing. Of the six samples submitted, 5 samples were classified as a CH material in accordance with USCS classification, and 1 sample was classified as MH. CH material is comprised of clay with high plasticity, also referred to as fat clay. MH material is comprised of silt of high plasticity, also referred to as lean silt. The vertical permeability of all samples was on the order of magnitude of 10^{-8} cm/sec. Based on the geotechnical data the clay materials located on the Site would be suitable for use as a capping material. The concentration of arsenic, cadmium, lead and zinc were less than the non-residential CLs in all clay material samples.

Samples were collected from trench TR-16 and test pits RSP-2 and RSP-3 (Figure 3)and submitted for agronomic testing, and laboratory analytical analysis for arsenic, cadmium, lead and zinc. The agronomic sample collected from trench TR-16 was collected at a depth of 2 feet below grade in native clay material. The agronomic samples from test pits RSP-2 and RSP-3 were collected at a depth of 5 feet below grade of the TCRA stockpile in clay and fill material.

The soil pH ranged from 6.6 to 7.3 for the three samples. The agronomic testing indicated all three samples had adequate levels of phosphorus, potassium, calcium and magnesium for plant growth, and did not suggest additional fertilization of the material was required to sustain plant growth. Based on the

agronomic sample analysis, soils from the area of TR-16 and the TCRA stockpile are suitable for use as vegetated growth media.

The sample collected from RSP-3 exceeded the CLs for non-residential use, and would not be suitable for use as a capping material. The sample collected from RSP-2 did not exhibit exceedances. Prior to the use of the soil from the TCRA stockpile as vegetated growth media, the soil will be sampled to verify material suitability for use.

3.2 Tarry Material Waste Characterization

During the RI tarry material was observed in one of the trenches excavated on the Facility Area. This material was not analyzed to fully evaluate its hazardous characteristics. Therefore during the PDI two samples of the tarry material were collected from two trenches (TR-1A and TR-7A) and submitted for waste characterization.

Based on the results of the samples collected as part of the PDI the tarry material observed at the Facility Area is determined to be non-hazardous and can be placed in the Consolidation Area.

3.3 Groundwater Evaluation

As part of the PDI, groundwater samples were collected from 15 monitoring wells and piezometers located on the Facility Area and three new wells drilled as part of the PDI immediately downgradient of the Facility Area. Site related COCs (cadmium and zinc) were identified at several wells located on the Facility Area at concentrations greater than the respective Class I Groundwater action level.

As previously discussed in the RI and PDI, the Site is not the source of manganese in groundwater. The down gradient extent of contamination from the Site, as indicated by the primary Site-related COC (zinc), has been adequately defined.

3.4 Residential, Commercial/Industrial and Vacant Property Sampling Evaluation

During the PDI fourteen properties were sampled for metals in soil. These properties included properties sampled during the TCRA for which insufficient information was available to determine if the property required remediation and properties for which the landowners had denied access to sample during the TCRA and/or RI. Exceedances of the residential CLs were found in five of the sampled properties.

4 REMEDIAL DESIGN

After the completion of the PDI field work and receipt of the laboratory data, the RD was initiated for all components of the RA in accordance with the AOC, as well as the schedule contained in the USEPA approved RD Work Plan.

The RD is being prepared to guide implementation of the selected remedial approach (Alternative 4A) and support attainment of remedial objectives and future possible reuse of the Facility Area. Section 1.1 identifies the components of the RD which includes, design of the Facility Area excavation; design and planning for the excavation and replacement of soils above the established CLs in residential, commercial and vacant properties and alleyways; design of the soil Consolidation Area, final grading of the Facility Area; the development of institutional land use controls; and ground water and surface water controls. The development of the environmental monitoring and Operation and Maintenance (O&M) plans will occur as part of the RA Work Plan development, and are not included in this draft Final RD Report.

4.1 Description and Objectives

The RA selected for the Site involves excavation, consolidation and capping of source materials, impacted soils and sediment that have concentrations of COCs above the defined CLs, and the handling of construction and demolition debris in a manner that meets all of the RAOs.

4.1.1 Performance Standards

The RA performance standards of the soil excavation is the removal and consolidation of source materials and affected soils exceeding the residential human health CLs, the removal and consolidation of sediments within the drainage ditches and Rose Creek exceeding applicable human health and ecological CLs, and the prevention of future off-Site migration of COCs (including metal-laden sediments). The Consolidation Area cover system was selected to prevent human contact with the consolidated material and to minimize storm water infiltration through the cap and underlying consolidated material into the underlying groundwater.

4.1.2 Design Considerations

The design and implementation of the RA is based on the following:

- The horizontal and vertical extent of source material, affected soils sediments, and construction debris, as identified by the RI and PDI;
- Final grades of the Consolidation Area are designed to accommodate the anticipated volume of material to be excavated from the Site, and is designed for ease of maintenance, minimization of erosion and for the control and management of storm water runoff;
- The final cover system for the Consolidation Area is designed with a low-permeability barrier layer to minimize infiltration and a vegetative cover layer to support a good stand of vegetation;

- Soils with concentrations of COCs less than the non-residential CLs were evaluated for use in the final cover system for the Consolidation Area. Soils with concentrations of COCs less than the residential CLs were also evaluated for use in final grading of the Facility Area based on their properties and the overall Site soil balance;
- The overall soil balance was evaluated to estimate the required quantity and types of off-Site borrow that will be required to complete the capping of the Consolidation Area and/or the final regrading of the excavated portions of the Facility Area. Based on a review of Site topography and proposed excavation depths there is an insufficient volume of borrow soil available from the excavated portions of the Site. Soils from the Site that are planned for use as borrow soils include the soil from the TCRA previously stockpiled on the Facility Area, soils underlying the Consolidation Area, and soils excavated from residential, commercial and vacant properties and alleyways that are below non-residential CLs (Consolidation Area only). The use of soils underlying the Consolidation Area will require that the existing source material and impacted soils be excavated from the footprint of the Consolidation Area prior to excavation of the borrow material. Borrow material could be excavated to a depth of 5 to 6 feet below original ground surface of the Consolidation Area and stockpiled for use in capping and/or regrading. Confirmation sampling will be performed on the excavated borrow material to ensure that the soils are below the appropriate CLs.
- The final RD includes regrading of the excavated areas on the Facility Area for positive drainage (no ponding water) and the re-establishment of vegetation. Based on post-excavation grades and the Site soil balance, some off-Site borrow material will be required to achieve final grades that provide positive drainage from the Facility Area.
- The affected residential, commercial and industrial properties and alleyways will be backfilled with off-Site borrow soil and restored to approximate pre-RA grades and condition.

The details of the RA Monitoring Program will be developed after the submission of the Final Design Report. The proposed Remedial Action Monitoring Program will be presented in the Performance Standard Verification Plan and the O&M Plan.

4.2 Institutional Controls

The RA will incorporate institutional controls to: prevent future potable use of ground water, prevent disturbance of the Consolidation Area cap and restrict future land use of the Consolidation Area and certain vacant properties to industrial and/or commercial uses. An outline for the ICIAP is presented in Appendix C.

A Groundwater Management Plan, prohibiting potable use of groundwater on the Facility Area, will be included in the RD Work Plan.

4.3 Draft Final Remedial Design

The DFRD includes: design of the Consolidation Area, design for ditches and drainages to be remediated, post-remedial topography drainage plans for the remediated areas of the Facility Area, and a description of the approach to remediate the residential, commercial and vacant properties and alleyways in the vicinity of the Facility Area. The DFRD also presents other relevant plans and calculations, material

volumes by type, volume of material to be transported off-Site, volume and specifications of required borrow soils, easement requirements, a preliminary construction schedule, and a discussion of how the RD complies with the Applicable and Reasonable Appropriate Requirements (ARARs).

Draft final design drawings are presented in **Appendix A**.

4.3.1 Excavation of Source Materials

The approximate base of the source materials on the Facility Area is shown on **Drawing 2** in **Appendix A**. Excavation to these grades will take place across the entire Facility Area, with the exception of the existing buildings and paved area in the eastern portion of the Facility Area. Excavation will continue until all visible source material is removed and confirmation sampling (XRF on a 100 x 100 foot grid) indicates that the remaining soil in the Excavation Area of the Facility Area is at or below residential standards for the COCs. A detailed confirmation sampling plan will be included in the RA Work Plan. The portions of the Facility Area north of the existing fence line will be addressed as described below for the Residential and Commercial Properties (Section 4.3.2)

In order to obtain borrow materials for capping of the Consolidation Area and re-grading of the Facility Area, excavation within the footprint of the Consolidation Area of underlying native clayey soils is planned to an elevation of 410 ft (msl). These proposed excavation grades of the Facility Area are presented on **Drawing 4** in **Appendix A**. Based on available soil boring data and ground water levels, the proposed Consolidation Area excavation will leave at least 6 feet of clayey soils, and be approximately 6 to 8 feet above the groundwater level.

4.3.2 Remediation of Identified Residential, Commercial and Vacant Properties and Alleyways

The approach for remediating portions of the identified residential, commercial and vacant properties with soils exceeding residential CLs will be to excavate up to 30 inches of soil from the affected area(s) of these properties, transport the excavated soil or gravel to the Consolidation Area, backfill the excavated area with clean, imported soil and restore the remediated areas to approximate original condition. If soils exceeding CLs exist below 30 inches, excavation will stop at 24 inches, and a barrier, such as an orange construction fence, will be placed prior to backfilling. The purpose of the barrier is to provide a visual marker in the event of any future excavation. It is not intended to be an impermeable barrier to water.

Confirmation sampling will be performed after the initial excavation and any subsequent excavation. The confirmation sampling will be performed in a manner consistent with the TCRA previously performed for this project. In general, this will involve collecting samples from the bottom of the excavation. For areas 10,000 sf or less, one sample will be collected. Areas greater than 10,000 sf will be divided into four equal sized grids for sampling. Details of the confirmation sampling will be included in the Field Sampling Plan, an outline for which is provided in Appendix C.

The soil excavated from the remediated residential, commercial and vacant properties will be transported to the Consolidation Area. Soil excavated that have concentrations of the COCs below the non-residential CLs may be used for the Consolidation Area cap system.

The soil excavated from alleyways exceeding the non-residential CLs will be excavated up to 30 inches in depth and transported to the Consolidation Area. The alleyways will be backfilled and restored to previous or like condition.

4.3.3 Drainages and Ditches

Based on the estimated base of source materials shown on **Drawing 2** in **Appendix A** and the available topographic mapping, the west ditches will be completely removed during the excavation of the source material. Approximately 1 foot of impacted sediments will be excavated from the bottom of the portion of Rose Creek and East Ditch to be remediated. The extent of the proposed remediation of Rose Creek and the East Ditch are shown on **Drawing 4** in **Appendix A.** This material will be replaced with clean soil or rock brought in from off-Site. A typical detail for the excavation and restoration of Rose Creek and East Ditch is presented as **Detail 3** on **Drawing 7** in **Appendix A**. As shown on the detail, approximately 1 foot of impacted soil will be excavated and replaced with soil below residential standards. Based on the depth and width of the East Ditch and Rose Creek, it is assumed that most, if not all, of the remediation work can be accomplished using a long-stick excavator situated at the top of the bank. If it becomes necessary for the Remedial Action Contractor to enter the ditch r creek to perform the required remediation, access points and methods will be discussed with the Owner,

New ditches will be created at the locations shown on **Drawing 5** in **Appendix A** to convey storm water from the regraded Facility Area to East Ditch and/or Rose Creek. A typical preliminary detail of the new ditches is presented as **Detail 4** on **Drawing 9** in **Appendix A**. The ditches will be typically 2 feet deep and 15 feet wide with 3H:1V side-slopes and a flow-line grade of 0.2%.

4.3.4 Design of Consolidation Area

On-Site materials to be excavated and placed in the Consolidation Area include slag, construction debris and affected soil from the Facility Area, some of the material from the existing stockpile of TCRA soil, excavated sediment, and material excavated from residential, commercial and vacant properties and alleyways. Estimated quantities are shown on **Drawing 7** in **Appendix A**, and discussed in Section 4.3.7. The Consolidation Area is designed with 4H:1V side slopes and top grades sloping at 3%. The 4H:1V side slopes extend to approximately 5 feet from the base of the Consolidation Area, with the top grades extending an additional 20 vertical feet at a 3% slope. Detail 1 on **Drawing 9** in **Appendix A** illustrates the proposed cap system.

The base grades of the Consolidation Area will be achieved by excavating native soil from below the source material within the footprint of the Consolidation Area. The most likely construction sequence for the Consolidation Area will involve:

- Mobilization, set up and initial clearing and grubbing;
- Excavation and stockpiling of source material adjacent to the Consolidation Area;
- Excavation and stockpiling of source material and affected soil from approximately one half of the Consolidation Area footprint

- Excavation of borrow soils from the prepared Consolidation Area footprint. Based on testing performed to date, the borrow soil excavated from below the Consolidation Area is believed to be suitable for both layers of the Consolidation Area cap system.
- Excavation of source material and affected soils from other areas of the Site and deposit of these materials into the Consolidation Area;
- Capping and grading of the Consolidation Area;
- Application of seed/fertilizer/mulch to the Consolidation Area; and
- Demobilization.

The calculations required to support the preliminary design of the Consolidation Area include:

- Material volume calculations,
- Storm Water Runoff/Ditch Sizing Calculations,
- Channel Lining Calculations,
- Soil Erosion Calculations (Consolidation Area Cap)
- Slope Stability Calculations.

The calculations are discussed in Section 4.3.6, and presented in **Appendix B**.

4.3.5 Post-Remedial Topography and Drainage Plan of the Facility Area

The preliminary post-remedial topography of the Facility Area is presented on **Drawing 7** in **Appendix A**. In general, the Facility Area will be graded at 0.5% toward the new ditches described above. Please note that the available topographic data does not provide sufficient detail to finalize the grading and drainage plan for the northwest corner and parts of the north and west perimeters of the Facility Area. Therefore, additional topographic surveys will be performed prior to developing the final design.

4.3.6 Calculations

4.3.6.1 Material Volume Calculations

Calculations were performed to estimate the volume of material to be excavated and deposited in the Consolidation Area, including:

- Facility Area Source Materials,
- Material excavated during the TCA and stockpiled within the facility area (70% assumed for use in capping the Consolidation Area and 30% to be deposited in the repository),
- Volume of Slag Stockpiles on the Facility Area (Listed separately for RA Planning),
- Volume of material to be excavated from Rose Creek and East Ditch (Total Length x 1’ depth x Typical Bottom Width of ditch/Creek),

- Volume of Material to be excavated from Residential and Commercial Properties (Area x 2-ft assumed average excavation depth) – 75% of this is assumed to be placed in the consolidation area with the other 25% to be used for the Consolidation Area cap,
- Volume of Material to be excavated from alleyways (length x 25-ft width x average of 2 feet of excavation depth).

The required volume of material required for Site restoration, including:

- Capping of the Consolidation Area (area x thickness),
- Regrading and revegetation of the Facility Area outside of the Consolidation Area,
- Restoration to grade of excavated residential and commercial properties (area x assumed average of 2-feet of excavation)
- Restoration to grade of excavated alleyways (as described above)
- Restoration of excavated portions of the East Ditch and Rose Creek (as described above).

4.3.7 Storm Water Runoff Calculations

Storm water runoff calculations were performed to evaluate the flow capacity of the ditches. The ditches are designed to convey the peak runoff from a 25-year/24-hour storm event within the defined ditches and Rose Creek. In addition, the majority of the peak discharge from the 100-year/24-hour storm event will be contained within the ditches and Rose Creek, with some minor short-term overtopping of parts of Rose Creek. Additional flow capacity is provided by the adjacent final topography which slopes at 0.5% toward the ditches and creek.

4.3.7.1 Ditch Lining Calculations

Calculations were performed to determine the type of channel lining that will be required to prevent long-term erosion of the proposed ditches. The calculations were performed using North American Green software, and were based on the proposed design discussed above, and the peak flows from the storm water runoff calculations. These calculations indicated that a temporary erosion control mat will be necessary until vegetation is established, and that grass-lining would be sufficient for long-term erosion protection.

4.3.7.2 Soil Erosion Calculations

The Revised Universal Soil Loss Equation was utilized to predict the soil erosion rate for the final cover of the Consolidation Area. This calculation yielded a result of 1.25 tons/acre/year, which is well below the standard of 5 tons/acre/year used for landfill cover design. Therefore, no additional erosion protection or ditches will be required for the Consolidation Area cap.

4.3.7.3 Slope Stability Calculations

The maximum slope proposed for the Consolidation Area is 4H:1V, with a maximum slope height of 5 feet. Due to the short slope height and moderate slope angle, a simple slope stability analysis is

appropriate in this case. Therefore, a simple infinite-slope model was utilized. This calculation yielded a factor of safety of 1.7, which exceeds the commonly accepted minimum of 1.5 for landfill slopes. It should be noted that this method is very conservative, and a more complex model would yield a significantly higher factor of safety.

4.3.8 Material Volumes

Materials to be excavated and transported to the Consolidation Area include:

- Soils excavated from the residential, commercial and vacant properties and alleyways as described above (42,900 cy).
- Slag from the piles located on the Facility Area (33,400 cy).
- Portions of the existing stockpile of TCRA soils located on the Facility Area. This material may be screened to remove large pieces of debris. The debris would be deposited in the Consolidation Area. The material passing the screen would be tested, and the material testing below residential standards would be used for general grading of the Facility Area while material testing above non-residential standards would be placed in the Consolidation Area. Material testing above residential but below non-residential CLs may be used in the construction of the Consolidation Area cap. At this time, it is assumed that 70% of this stockpile will be available for capping (13,300 cy) and 30% (5,700 cy) will be placed in the Consolidation Area.
- Source material, including the tarry material, concrete and miscellaneous debris within the building foundations located on the Facility Area (712,600 cy).
- Material excavated from Rose Creek, East Ditch and the West Ditch Outfall (700 cy).

4.3.8.1 Volume of Material to be Transported off-Site for Disposal/Recycling

Equipment, rail and other metal objects encountered during excavation on the Facility Area will be either recycled off-Site or disposed of in the Consolidation Area. It is not possible to quantify the amount of material that may be transported off-site for recycling. Therefore, for the purposed of this design, it is assumed that all of this material will be placed in the Consolidation Area.

4.3.8.2 Volume and Specifications of Required Borrow Materials

Required borrow materials include: low permeability cap layer, vegetative cap layer, general grading fill, and final grading fill. The estimated required volume of borrow soils required are as follows:

- Low permeability cap layer – 111,900 cy (35 ac)
- Vegetative cap layer – 55,900 cy (35 ac)
- General grading fill (fill placed in excavated areas, exclusive of the top 1-foot) – 60,200 cy
- Final grading fill (top 1-foot of backfill in the excavated areas) – 206,800 cy

A list of detailed specifications is included in the outline for the Construction Quality Assurance Plan presented in Appendix C.

General specifications for these soils are as follows:

The concentration of COCs in general grading fill and final grading fill for the excavated area of the Facility Area must be below the residential CLs .General grading fill cannot have significant amounts of large rock greater than 4" nor significant amounts of organic debris. The final grading material must be reasonably free of large rocks greater than 3" and be capable of sustaining a good stand of vegetation. The concentration of COCs in soils used to construct the cap of the Consolidation Area must be below non-residential CLs. The low permeability cap layer soils must be CL (lean clay), CH (fat clay), CL-ML (silty clay – silt) or similar classification, be substantially free of large rock (>3"), and cannot contain significant amounts of organic or inorganic debris, such as vegetation, roots, wood, rubble or other deleterious material, and be can capable of yielding a low permeability after compaction. The vegetative cap layer must be reasonably free of large rocks greater than 3" and be capable of sustaining a good stand of vegetation.

4.3.9 Easement and Permit Requirements

No easements will be required for the RA. Access to the Facility Area and the residential, commercial and vacant properties and alleyways to be addressed by the RA must be obtained prior to the remedy.

Under Section 121(e) of CERCLA, no Federal, state or local permits are required for a remedial action conducted entirely on site; however, a SWPPP will be prepared and submitted to IEPA prior to earthwork activities.

4.3.10 Preliminary Construction Schedule

A preliminary construction schedule, including time for the selection of an earthwork contractor, is presented as **Figure 5**.

4.3.11 RD Compliance with ARARs

4.3.11.1 Chemical-Specific ARARs

Chemical-specific ARARs for surface water will be met in storm water run-off from the Facility Area to the man-made ditches and Rose Creek by removing impacted sediment and soils in conjunction with the Facility Area remediation. Surface water ARARs will continue to be exceeded within Rose Creek because of upstream sources of metal loadings to these drainages.

Chemical-specific ARARs for potable groundwater cannot be met due to off-Site upgradient metal loadings to the shallow groundwater at levels that exceed these standards. Affected groundwater will be addressed through the use of a Groundwater Management Plan to prohibit well installation and groundwater use on the Facility Area or downgradient properties where exceedances of applicable groundwater standards are present.

Fugitive dust emissions during the implementation of the RD have a potential of exceeding the chemical-specific ARARs for air. Therefore, dust control measures capable of preventing these exceedances will be included in the RA Work Plan and implemented during the RA.

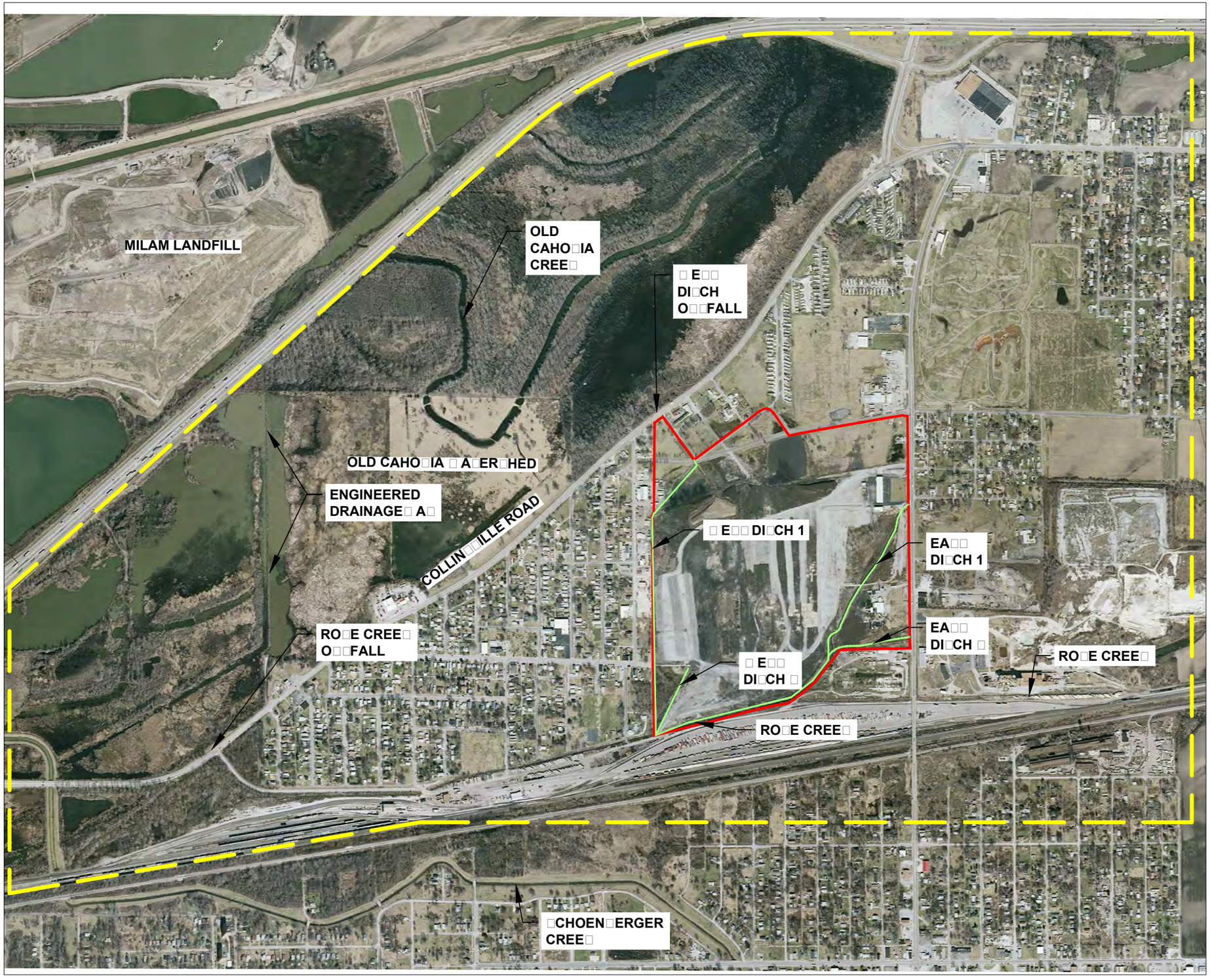
4.3.11.2 Action-Specific ARARs

The proposed design is capable of complying with all action-specific ARARs (listed in Table 5-2 of the FS Report). The RD meets the Illinois regulation (35 IAC 807.305(c)) on cover system thickness regulations which requires a minimum of 24 inches of compacted low permeability soils. The design also complies with Site-specific ARARs aimed at controlling storm water run-off and seepage from source materials and affected media with full implementation of BMPs as they relate to erosion and sediment controls and storm water controls for pollution prevention during construction.

4.3.11.3 Location-Specific ARARs

The RD will comply with all location-specific ARARs (Listed in Table 5-3 of the FS Report). The Consolidation Area will be located outside of hazardous zones and no actions will be taken in wetlands, historically significant properties or other regulated areas. No endangered or threatened species have been identified to occur on the Site based on databases contained by USFWS and a survey conducted as part of the RI (ENTACT, 2009).

FIGURES



0 1000 FEET

LEGEND

- FACILITY AREA BOUNDARY
- EXISTING DITCH LINE
- SITE BOUNDARY (APPROXIMATE)

NOTE:
FIGURE BASED ON INFORMATION INCLUDED IN RI/FS FIGURES BY ENTACT MARCH 2009

BLUE TEE CORP.
OLD AMERICAN ZINC SITE
FAIRMONT CITY, ILLINOIS
REMEDIAL DE□IGN

□I□E PLAN AND E□I□□ING CONDI□ION□

ARCADIS

FIGURE
1

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0 500 FEET

LEGEND

- FACILITY AREA BOUNDARY
- EXISTING DITCH LINE
- PROPOSED CONSOLIDATION AREA
- PROPOSED EXCAVATION AREA
- EXISTING STOCKPILED SLAG BOUNDARY
- STOCKPILED SLAG
- SOIL STOCKPILE ON TOP OF SLAG

NOTE:
FIGURE BASED ON INFORMATION INCLUDED IN RI/FS FIGURES BY ENTACT MARCH 2009

BLUE TEE CORP.
OLD AMERICAN ZINC SITE
FAIRMONT CITY, ILLINOIS
REMEDIAL DE□IGN

DEFINED AREA□ OF □HE FACILI□□ AREA

ARCADIS

FIGURE
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LEGEND

- FACILITY AREA BOUNDARY
- EXISTING DITCH LINE
- PROPOSED CONSOLIDATION AREA
- PROPOSED EXCAVATION AREA
- EXISTING STOCKPILED SLAG BOUNDARY
- STOCKPILED SLAG
- SOIL STOCKPILE ON TOP OF SLAG
- EXISTING TRENCH LOCATION
- PRE DESIGN INVESTIGATION TRENCH LOCATION
- ⊗ TEST PIT
- CTP CONSOLIDATION TEST PIT
- RSP RESIDENTIAL SOIL STOCKPILE PIT
- ETP EXCAVATION AREA TEST PIT

NOTE:
FIGURE BASED ON INFORMATION INCLUDED IN RI/FS FIGURES BY ENTACT MARCH 2009

BLUE TEE CORP.
OLD AMERICAN ZINC SITE
FAIRMONT CITY, ILLINOIS
REMEDIAL DESIGN

TRENCH AND TEST PIT LOCATIONS

ARCADIS

FIGURE

NOTE:
(1)FIGURE BASED ON INFORMATION PROVIDED TO ARCADIS BY ENTACT ON MARCH 29, 2016.

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SCALE IN FEET

LEGEND

- FACILITY AREA BOUNDARY
- PROPOSED CONSOLIDATION AREA
- PROPERTIES TO BE ADDRESSED
- ALLEYWAYS REQUIRING REMEDIATION

FIGURE ID	ENTACT ID	Property Class	PROPERTY ADDRESS		Remediation Area	Depth (Inches)
1	011C	Commercial	2870	N 45th St	BH1	6
2	016C	Commercial	2800	N 45th St	FH2	12
3	029R	Vacant		N 48th St	FY/BY	6/6
4	043R	Vacant	2746	N 44th St	FY	6
5	052C	Com/Ind	4510	Cookson Rd	BY	12
6	079R	Vacant		N 45th St	FY1/FY2/BY1/BY2	18/12/18/12
7	081R	Vacant		N 45th St	FY/BY	12/6
8	095R	Vacant		Collinsville Rd (Woodrow Av	FY1/FY2/BY1	12/6/6
9	105R	Vacant	2748	N 43rd St	BY	6
10	110C	Vacant		N 45th St	Q4	6
11	112R	Vacant		Maryland Ave	FY/BY	18/12
12	113R	Vacant		Maryland Ave	FY2/BY2	12/6
13	123R	Vacant		N 43rd St	FY1/BY1/BY2	18/6/6
14	138R		2552	N 43rd St	BY	24
15	139R	Residential		N 45th St	FY/BY	6/6
16	151R	Residential		N 44th St	FY/BY	18/6
17	152R	Residential		Cookson Rd	BY	6
18	155R	Vacant		N 45th St	FY/BY	12/12
19	156R	Vacant		N 45th St	FY1/FY2/BY1	12/6/6
20	160R	Vacant		Maryland Ave	FY/BY	18/6
21	169R	Vacant		N 45th St	FY/BY	18/18
22	178R	Vacant		Kingshighway	BY	6
23	179R	Residential		N 44th St	FY/BY	12/18
24	181R		2748	N 43rd St	BY	6
25	184R	Vacant		Delmar Ave	FY/BY	6/6
26	195R	Vacant		N 52nd St	FY1/FY2/BY1/BY2	6/6/6/6
27	199R	Residential		N 43rd St	BY	12
28	200R		2831	N 45th St	FY1	18
29	232R	Residential		N 41st St	FY/BY	6/18
30	233R	Vacant	5000	Collinsville Rd	FY/BY	12/12
31	234R	Vacant	2829	N 44th St	FY/BY	18/12
32	241R	Vacant		N 48th St	FY1/FY2/BY1/BY2	6/6/6/18
33	242R	Vacant		N 48th St	BY	12
34	243R	Vacant		N 47th St	BY	6
35	244R	Vacant		N 48th St	FY/BY	12/6
36	245R	Vacant		Woodrow Ave	FY1/FY2/BY1	6/18/6
37	250C	Vacant	4800	Collinsville Rd	BY2	12
38	252R	Vacant	2740	N 42nd St	BY	12
39	256R		2825	N 45th St	BY	6
40	277R	Vacant		N 48th St	FY/BY	6/6
41	279R	Vacant		N 45th St	FY1/FY2/BY1/BY2	6/6/6/6
42	282R	Church	2733	N 44th St	BY1	6
43	286C	Com/Ind	2730	N 45th St	FY2/BY1	6/18
44	287R	Residential		Locust St	FY/BY	6/12
45	321R	Vacant	2757	N 45th St	FY/BY	12/18
46	345R	Vacant		Delmar Ave	FY/BY	18/18
47	348R	Residential		Cookson Rd	FY	18
48	351R		4019	Locust St	BY	12
49	355C	Residential		N 41st St	FY2/BY2	6/12
50	361R	Residential		Thomas Ave	BY	6
51	366R	Vacant		Maple Ave	FY/BY	18/12
52	368R	Residential		Cookson Rd	FY/BY	6/6
53	371R	Residential		Locust St	BY	18
54	378R	Residential		Collinsville Rd	FY1/BY1	6/6
55	398R	Residential		Collinsville Rd	BY	12
56	401C	Vacant		Maryland Ave	FY/BY	6/18
57	402R	Vacant	2502	N 39th St	BY	12
58	404C	Com/Ind		Maryland Ave	BY	18
59	423C	Com/Ind		N 45th St	FY1/FY2/BY1/BY2	6/6/6/6
60	436R	Com/Ind		N 42nd St	BY	6
61	439R	Residential		N 36th St	BY	18
62	440R	Vacant		N 50th St	FY/BY	18/18
63	443R	Com/Ind		N 52nd St	BY1	6
64	467R	Vacant	2781	N 42nd St	BY	12
65	469R	Com/Ind		Collinsville Rd	FY/BY	6/6
66	470R	Residential		Collinsville Rd	FY2	6
67	474R	Vacant		Koenigsmark Ave	FY1/BY2	6/12
68	475C	Residential		Maryland Ave	BY1	6
69	600R	Residential	2323	N 48th St	BY2	6
70	602R	Residential	2769	N. 43rd St	FY1/BY2	24/24
71		Residential		N 48th St	All	12
72		Residential	5514	Kinder	SE/SW	6/1
73		Residential	2845	N. 44th St	SE Quad/SW Quad	12/6
74		Residential		N. 42nd St	?	?
75		Commercial	4012	Maple	SY	24
76		Residential		N 47th St	BY/FY	6/1
77		Residential		Maryland Ave	NE/NW/SE/SW	12/12/6/6

BLUE TEE CORP.
OLD AMERICAN ZINC SITE
FAIRMONT CITY, ILLINOIS
REMEDIAL DE□IGN

OFF FACILI□□ PROPER□IE□
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FIGURE
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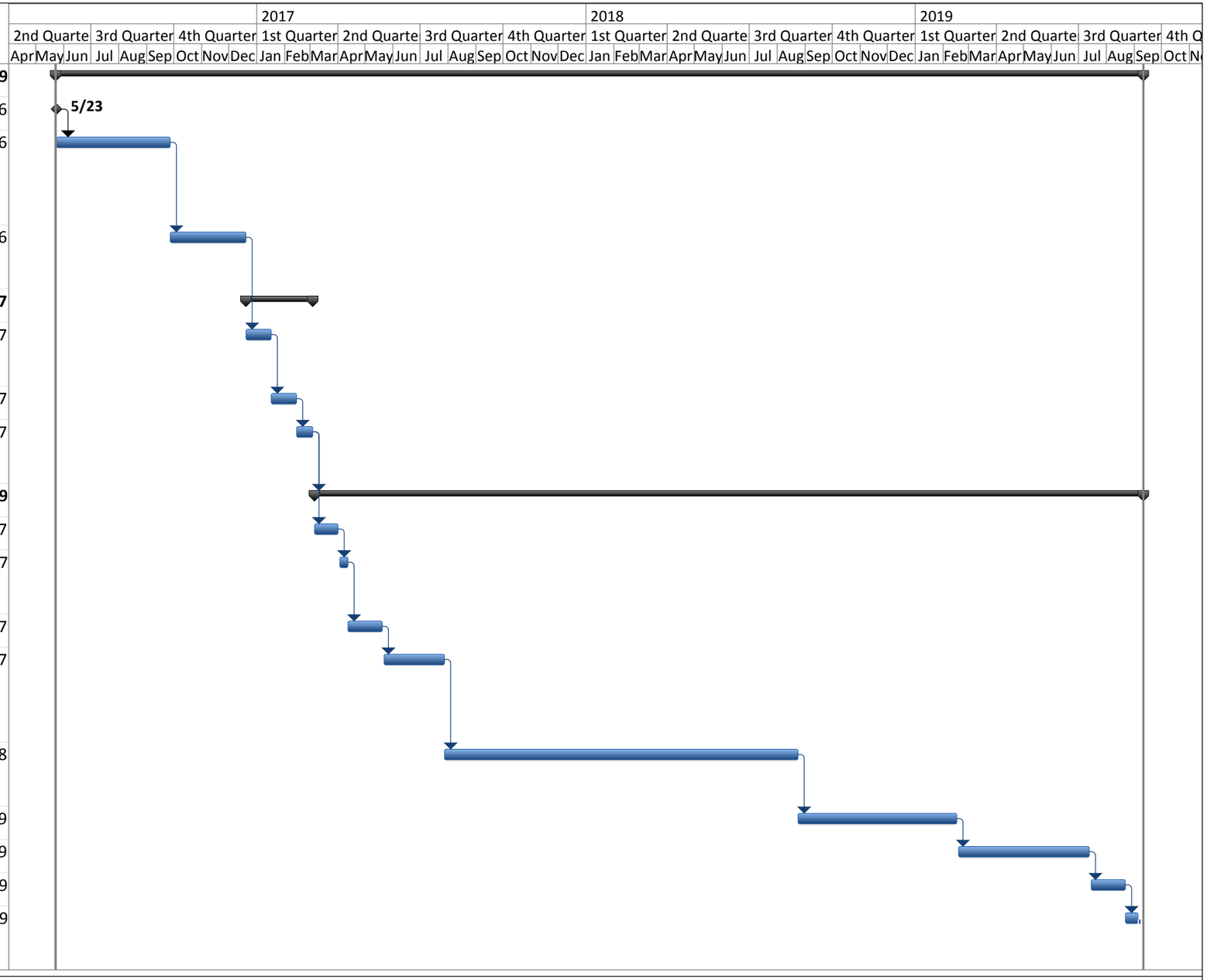
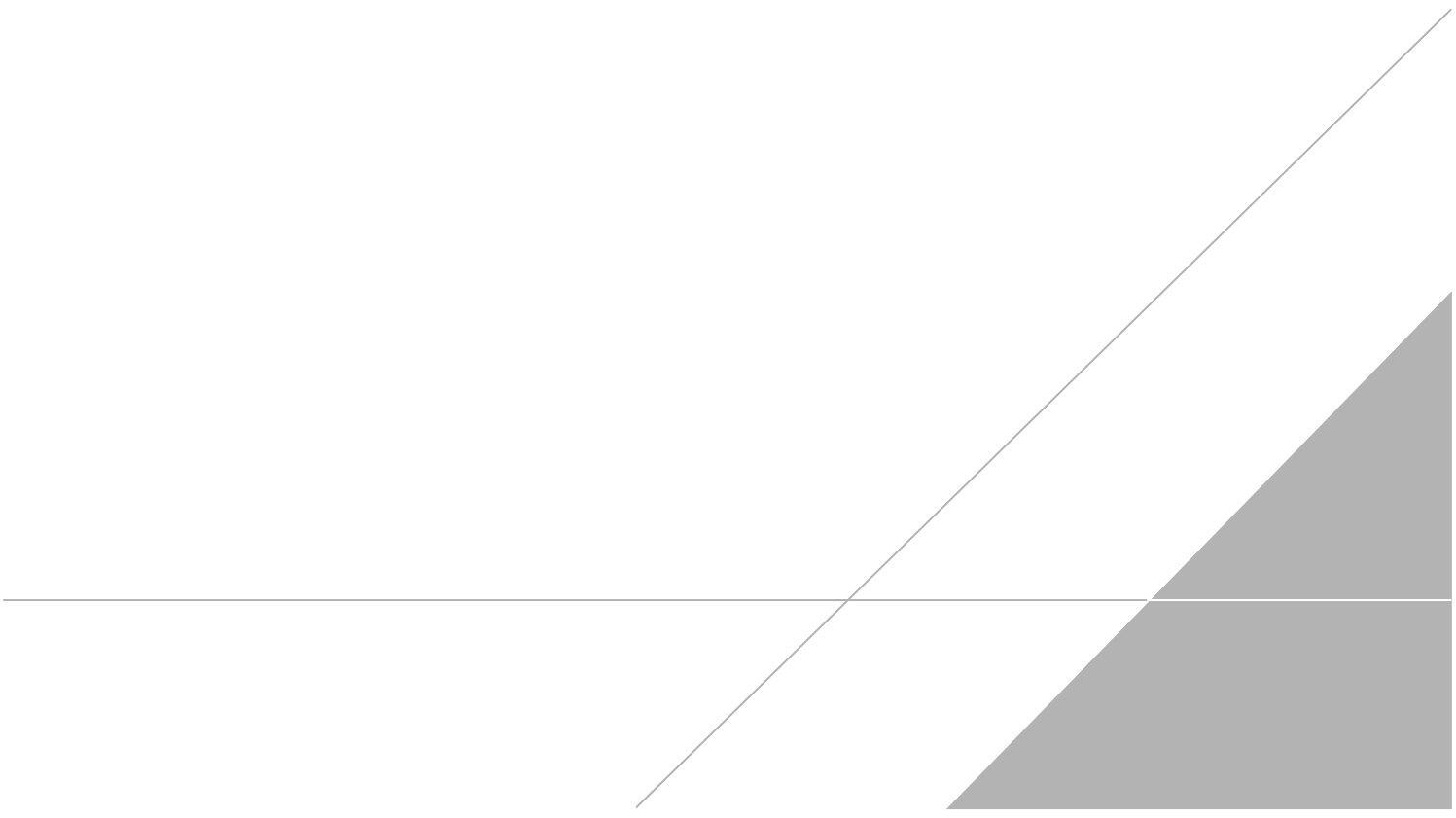
ID		Task Name	Duration	Start	Finish
1		**Construction Schedule**	**862 days**	**Mon 5/23/16**	**Tue 9/10/19**
2		Submittal of Final RD	1 day	Mon 5/23/16	Mon 5/23/16
3		Prepare Site Documents (Outlines in RD)	90 days	Tue 5/24/16	Mon 9/26/16
4		USEPA/IEPA Review of Site Documents	60 days	Tue 9/27/16	Mon 12/19/16
5		**Contractor Selection**	**54 days**	**Tue 12/20/16**	**Fri 3/3/17**
6		Preparation of Bid Documents	1 mon	Tue 12/20/16	Mon 1/16/17
7		Bid Solicitation	1 mon	Tue 1/17/17	Mon 2/13/17
8		Review Bids and Select Contractor	2 wks	Tue 2/14/17	Fri 3/3/17
9		**Construction**	**657 days**	**Mon 3/6/17**	**Tue 9/10/19**
10		Mobilization	1 mon	Mon 3/6/17	Fri 3/31/17
11		Set up and Site Prep	1 wk	Mon 4/3/17	Tue 4/11/17
12		Initial Excavation	4 wks	Wed 4/12/17	Fri 5/19/17
13		Initial Repository Excavation and Stockpiling	7 wks	Mon 5/22/17	Thu 7/27/17
14		Mass Excavation and Stockpiling	40 wks	Fri 7/28/17	Thu 8/23/18
15		Capping	18 wks	Fri 8/24/18	Fri 2/15/19
16		Site Regrading	15 wks	Mon 2/18/19	Fri 7/12/19
17		Seed/Fertilize/Mulch	4 wks	Mon 7/15/19	Wed 8/21/19
18		Final Site Work/Demobilization	2 wks	Thu 8/22/19	Tue 9/10/19



Project: Preliminary RA Construction
Date: Thu 12/17/15

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

Figure 5
Old American Zinc SIte, Fairmont City, IL
Preliminary RA Construction Schedule



APPENDIX A

Drawings

0 200 400
SCALE IN FEET

LEGEND

- 422 — EXISTING CONTOUR
- FACILITY AREA BOUNDARY
- EXISTING DITCH LINE
- EXISTING FENCE LINE
- EXISTING CULVERT
- PROPOSED CONSOLIDATION AREA

NOTE:

1) SITE TOPOGRAPHY BASED ON GROUND SURVEY BY SHEPPARD, MORGAN & SCHWAAB, INC., COMPLETED ON 3/3/2016

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Professional Engineer's Name: JOHN HOLM
Professional Engineer's No.:

State	Date Signed	Project Mgr.
		RJK
Designed by	Drawn by	Checked by
	MJC	JWH

ARCADIS U.S., INC.

FACILI□□ AREA
E□I□□ING CONDI□ION□

ARCADIS Project No.
HA100254.0000.00000

Date
03-24-2016

ARCADIS
4665 CORNELL ROAD
SUITE 350
CINCINNATI, OHIO 45241
TEL. 513.860.8700

0 200 400
SCALE IN FEET

LEGEND

- 422 — EXISTING CONTOUR
- 422 — BOTTOM OF SOURCE MATERIAL
- FACILITY AREA BOUNDARY
- PROPOSED CONSOLIDATION AREA
- 418.740 SB-65-NE — EXISTING SOIL BORING WITH BOTTOM OF SOURCE MATERIAL ELEVATIONS
- EXISTING DITCH LINE
- EXISTING FENCE LINE
- EXISTING CULVERT

NOTE:

1) BOTTOM OF SOURCE MATERIAL GRADES ARE APPROXIMATE, AND ARE BASED ON SOIL BORINGS. ACTUAL FINAL EXCAVATION ELEVATIONS WILL BE BASED ON THE ACTUAL DEPTH OF SOURCE MATERIAL ENCOUNTERED DURING THE EXCAVATION.

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Professional Engineer's Name: JOHN HOLM
Professional Engineer's No.:

State	Date Signed	Project Mgr.
		RJK
Designed by	Drawn by	Checked by
	MJC	JWH

ARCADIS U.S., INC.

APPRO□IMA□E □O□□OM OF □O□RCE MA□ERIAL GRADE□

ARCADIS Project No.
HA100254.0000.00000

Date
03-24-2016

ARCADIS
4665 CORNELL ROAD
SUITE 350
CINCINNATI, OHIO 45241
TEL. 513.860.8700

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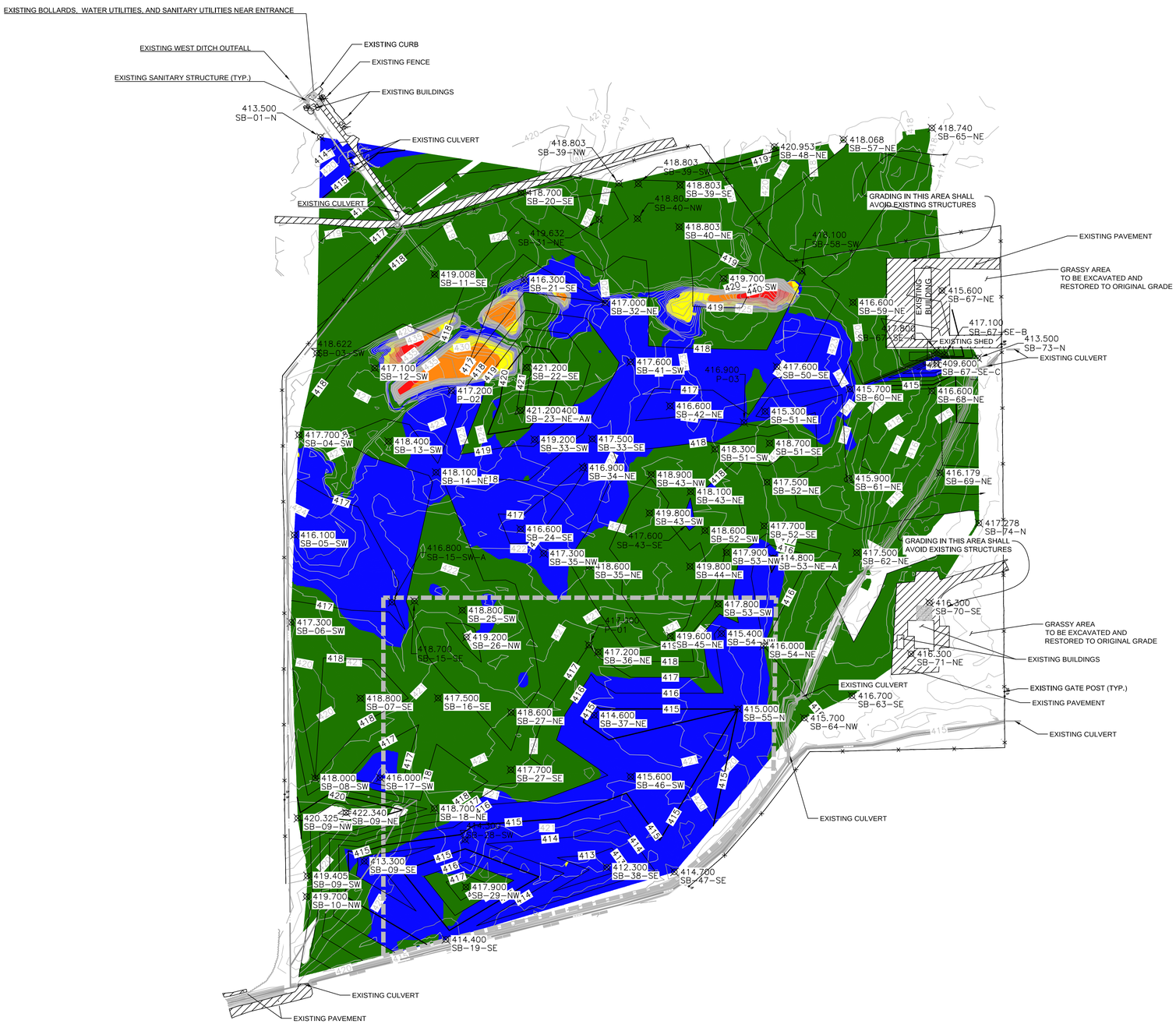

LEGEND

- 422 — EXISTING CONTOUR
- 422 — BOTTOM OF SOURCE MATERIAL
- FACILITY AREA BOUNDARY
- PROPOSED CONSOLIDATION AREA
- 418.740 SB-65-NE — EXISTING SOIL BORING WITH BOTTOM OF SOURCE MATERIAL ELEVATIONS
- EXISTING DITCH LINE
- EXISTING FENCE LINE
- EXISTING CULVERT

DEPTH OF SOURCE MATERIAL

Elevations Table				
Number	Minimum Elevation	Maximum Elevation	Color	Area (sq.ft.)
1	−50.000	−20.000		17491
2	−20.000	−15.000		51240
3	−15.000	−10.000		44980
4	−10.000	−5.000		1906126
5	−5.000	0.000		3643904

NOTE:

1) BOTTOM OF SOURCE MATERIAL DEPTHS ARE APPROXIMATE, AND ARE BASED ON SOIL BORINGS. ACTUAL FINAL EXCAVATION ELEVATIONS WILL BE BASED ON THE ACTUAL DEPTH OF SOURCE MATERIAL ENCOUNTERED DURING THE EXCAVATION.

SCALE(S) AS INDICATED

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Professional Engineer's No.:

State	Date Signed	Project Mgr.
		RJK
Designed by	Drawn by	Checked by
	MJC	JWH

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APPRO□IMA□E □O□RCE MA□ERIAL DEP□H

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Date
03-24-2016

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4665 CORNELL ROAD
SUITE 350
CINCINNATI, OHIO 45241
TEL. 513.860.8700

□ of □

LEGEND

- EXISTING CONTOUR (422)
- TOP OF EXCAVATION CONTOUR (422)
- FACILITY AREA BOUNDARY
- PROPOSED CONSOLIDATION AREA
- EXISTING SOIL BORING WITH BOTTOM OF SOURCE MATERIAL ELEVATIONS (418.740 SB-65-NE)
- EXISTING DITCH TO BE REMEDIATED
- EXISTING DITCH TO BE COMPLETELY EXCAVATED DURING SOURCE EXCAVATION
- EXISTING FENCE LINE
- EXISTING CULVERT

NOTE:

1) BOTTOM OF SOURCE MATERIAL GRADES ARE APPROXIMATE, AND ARE BASED ON SOIL BORINGS. ACTUAL FINAL EXCAVATION ELEVATIONS WILL BE BASED ON THE ACTUAL DEPTH OF SOURCE MATERIAL ENCOUNTERED DURING THE EXCAVATION.

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No.	Date	Revisions	By	Ckd

Professional Engineer's Name: JOHN HOLM

Professional Engineer's No.:

State	Date Signed	Project Mgr.
		RJK
Designed by	Drawn by	Checked by
	MJC	JWH

ARCADIS U.S., INC.

PROPO□ED E□CA□A□ION GRADE□

ARCADIS Project No.
HA100254.0000.00000

Date
03-24-2016

ARCADIS
4665 CORNELL ROAD
SUITE 350
CINCINNATI, OHIO 45241
TEL. 513.860.8700

□ of □

0 200 400
SCALE IN FEET

LEGEND

- 422 — EXISTING CONTOUR
- 422 — TOP OF EXCAVATION CONTOUR
- FACILITY AREA BOUNDARY
- PROPOSED CONSOLIDATION AREA
- 418.740 SB-65-NE — EXISTING SOIL BORING WITH BOTTOM OF SOURCE MATERIAL ELEVATIONS
- EXISTING DITCH TO BE REMEDIATED
- EXISTING FENCE LINE
- EXISTING CULVERT

NOTES:

1) BOTTOM OF SOURCE MATERIAL GRADES ARE APPROXIMATE, AND ARE BASED ON SOIL BORINGS. ACTUAL FINAL EXCAVATION ELEVATIONS WILL BE BASED ON THE ACTUAL DEPTH OF SOURCE MATERIAL ENCOUNTERED DURING THE EXCAVATION.

2) TOP OF WASTE GRADES WITHIN CONSOLIDATION AREA ARE APPROXIMATE AND WILL BE ADJUSTED AS NECESSARY TO ACCOMODATE THE VOLUME OF SOURCE MATERIAL AND EXCAVATED SOIL ACTUALLY ENCOUNTERED DURING THE SITE REMEDIATION.

3) FINAL CONSOLIDATION AREA SLOPES WILL BE NO STEEPER THAN 4H:1V NOR FLATTER THAN 3%.

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Designed by	Drawn by	Checked by
	MJC	JWH

ARCADIS U.S., INC.

PROPO□ED □O□RCE MA□ERIAL E□CA□A□ION AND CON□OLIDA□ION AREA □OP OF □ A□□E GRADE□

ARCADIS Project No.
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LEGEND

- FACILITY AREA BOUNDARY
- PROPOSED CONSOLIDATION AREA
- PROPERTIES TO BE ADDRESSED
- ALLEYWAYS REQUIRING REMEDIATION

FIGURE ID	ENTACT ID	Property Class	PROPERTY ADDRESS		Remediation Area	Depth (Inches)
1	011C	Commercial	2870	N 45th St	BH1	6
2	016C	Commercial	2800	N 45th St	FH2	12
3	029R	Vacant		N 48th St	FY/BY	6/6
4	043R	Vacant	2746	N 44th St	FY	6
5	052C	Com/Ind	4510	Cookson Rd	BY	12
6	079R	Vacant		N 45th St	FY1/FY2/BY1/BY2	18/12/18/12
7	081R	Vacant		N 45th St	FY/BY	12/6
8	095R	Vacant		Collinsville Rd (Woodrow A	FY1/FY2/BY1	12/6/6
9	105R	Vacant	2748	N 43rd St	BY	6
10	110C	Vacant		N 45th St	Q4	6
11	112R	Vacant		Maryland Ave	FY/BY	18/12
12	113R	Vacant		Maryland Ave	FY2/BY2	12/6
13	123R	Vacant		N 43rd St	FY1/BY1/BY2	18/6/6
14	138R		2552	N 43rd St	BY	24
15	139R	Residential		N 45th St	FY/BY	6/6
16	151R	Residential		N 44th St	FY/BY	18/6
17	152R	Residential		Cookson Rd	BY	6
18	155R	Vacant		N 45th St	FY/BY	12/12
19	156R	Vacant		N 45th St	FY1/FY2/BY1	12/6/6
20	160R	Vacant		Maryland Ave	FY/BY	18/6
21	169R	Vacant		N 45th St	FY/BY	18/18
22	178R	Vacant		Kingshighway	BY	6
23	179R	Residential		N 44th St	FY/BY	12/18
24	181R		2748	N 43rd St	BY	6
25	184R	Vacant		Delmar Ave	FY/BY	6/6
26	195R	Vacant		N 52nd St	FY1/FY2/BY1/BY2	6/6/6/6
27	199R	Residential		N 43rd St	BY	12
28	200R		2831	N 45th St	FY1	18
29	232R	Residential		N 41st St	FY/BY	6/18
30	233R	Vacant	5000	Collinsville Rd	FY/BY	12/12
31	234R	Vacant	2829	N 44th St	FY/BY	18/12
32	241R	Vacant		N 48th St	FY1/FY2/BY1/BY2	6/6/6/18
33	242R	Vacant		N 48th St	BY	12
34	243R	Vacant		N 47th St	BY	6
35	244R	Vacant		N 48th St	FY/BY	12/6
36	245R	Vacant		Woodrow Ave	FY1/FY2/BY1	6/18/6
37	250C	Vacant	4800	Collinsville Rd	BY2	12
38	252R	Vacant	2740	N 42nd St	BY	12
39	259R		2825	N 45th St	BY	6
40	277R	Vacant		N 48th St	FY/BY	6/6
41	278R	Vacant		N 45th St	FY1/FY2/BY1/BY2	6/6/6/6
42	282R	Church	2733	N 44th St	BY1	6
43	286C	Com/Ind	2730	N 45th St	FY2/BY1	6/18
44	287R	Residential		Locust St	FY/BY	6/12
45	321R	Vacant	2757	N 45th St	FY/BY	12/18
46	345R	Vacant		Delmar Ave	FY/BY	18/18
47	348R	Residential		Cookson Rd	FY	18
48	351R		4019	Locust St	BY	12
49	355C	Residential		N 41st St	FY2/BY2	6/12
50	361R	Residential		Thomas Ave	BY	6
51	366R	Vacant		Maple Ave	FY/BY	18/12
52	368R	Residential		Cookson Rd	FY/BY	6/6
53	371R	Residential		Locust St	BY	18
54	378R	Residential		Collinsville Rd	FY1/BY1	6/6
55	398R	Residential		Collinsville Rd	BY	12
56	401C	Vacant		Maryland Ave	FY/BY	6/18
57	402R	Vacant	2502	N 39th St	BY	12
58	404C	Com/Ind		Maryland Ave	BY	18
59	423C	Com/Ind		N 45th St	FY1/FY2/BY1/BY2	6/6/6/6
60	436R	Com/Ind		N 42nd St	BY	6
61	439R	Residential		N 36th St	BY	18
62	440R	Vacant		N 50th St	FY/BY	18/18
63	443R	Com/Ind		N 52nd St	BY1	6
64	467R	Vacant	2781	N 42nd St	BY	12
65	469R	Com/Ind		Collinsville Rd	FY/BY	6/6
66	470R	Residential		Collinsville Rd	FY2	6
67	474R	Vacant		Koenigsmark Ave	FY1/BY2	6/12
68	475C	Residential		Maryland Ave	BY1	6
69	600R	Residential		N 48th St	BY2	6
70	602R	Residential		N. 43rd St	FY1/BY2	24/24
71		Residential		N 48th St	All	12
72		Residential		Kinder	SE/SW	6/1
73		Residential		N. 44th St	SE Quad/SW Quad	12/6
74		Residential		N. 42nd St	?	?
75		Commercial	4012	Maple	SY	24
76		Residential		N 47th St	BY/FY	6/1
77		Residential		Maryland Ave	NE/NW/SE/SW	12/12/6/6

NOTE:
(1)FIGURE BASED ON INFORMATION PROVIDED TO ARCADIS BY ENTACT ON MARCH 29, 2016.

SCALE(S) AS INDICATED

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Professional Engineer's Name: JOHN HOLM		
Professional Engineer's No.		
State	Date Signed	Project Mgr. RJK
Designed by	Drawn by MAC	Checked by JWH

ARCADIS U.S., INC.

OFF FACILI□□ PROPER□IE□ □O □E ADDRE□□ED

ARCADIS Project No. HA100254.0000.00000

Date 3-29-2016

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SCALE IN FEET

LEGEND

- EXISTING CONTOUR (422)
- PROPOSED CONTOUR (422)
- FACILITY AREA BOUNDARY
- PROPOSED CONSOLIDATION AREA
- PROPOSED DRAINAGE DITCH FLOW LINE
- EXISTING DITCH TO BE REMEDIATED
- PROPOSED FENCELINE
- EXISTING FENCE LINE
- EXISTING CULVERT

SOURCE MATERIALS	
ON-SITE MATERIAL, EXCLUSIVE OF SLAG PILES	712,554 CY
SLAG PILES	33,414 CY
UNUSABLE MATERIAL FROM OFF-SITE PROPERTIES (75% OF OFF-SITE MATERIAL)	42,889 CY
1FT DITCH EXCAVATION	660 CY
30% OF SOIL STOCKPILE	5,690 CY
TOTAL SLAG/IMPACTED SOILS	*795,207 CY*
REPOSITORY VOLUME	
REPOSITORY AREA CAPACITY	853,300 CY
ADDITIONAL AVAILABLE CAPACITY	58,093 CY
REQUIRED SOIL CAP VOLUME	
-2FT CLAY LINER	111,862 CY
-1FT VEGETATIVE SOIL	55,913 CY
TOTAL CAP VOLUME	*167,775 CY*
REGRADING VOLUME	
RESTORATION GRADING (CUT)	19,185 CY
RESTORATION GRADING (FILL)	286,997 CY
RESTORATION GRADING (NET FILL)	267,812 CY
TOTAL SOIL REQUIRED (FACILITY AREA)	
RESTORATION GRADING AND CAPPING	436,247 CY
ON-SITE BORROW SOILS	
CLAY BORROW EXCAVATION (BELOW REPOSITORY)	333,140 CY
SOIL STOCKPILE ASSUME 70% AVAILABLE BORROW	13,276 CY
TOTAL AVAILABLE ON-SITE BORROW SOIL	*346,416 CY*
BORROW SOILS FROM EXCAVATED OFF-SITE PROPERTIES	
USABLE MATERIAL FROM OFF-SITE PROPERTIES (25% OF OFF-SITE MATERIAL)	14,296 CY
ADDITIONAL SOIL REQUIRED	
RESTORATION GRADING	75,535 CY
CLEAN SOIL TO BE HAULED TO OFF-SITE PROPERTIES *	57,185 CY

*NOTE: THE CLEAN SOIL TO BE HAULED IN WAS CALCULATED AS A FUNCTION OF TOTAL RESIDENTIAL/VACANT/INDUSTRIAL LOT SIZE, AS SOIL UNDER EXISTING STRUCTURES AND PAVEMENT MAY NOT BE EXCAVATED THE ACTUAL NUMBER MAY BE REDUCED IN FUTURE SUBMITTALS.

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Professional Engineer's Name: JOHN HOLM
Professional Engineer's No.:

State	Date Signed	Project Mgr.
		RJK
Designed by	Drawn by	Checked by
	MJC	JWH

ARCADIS U.S., INC.

PROPO□ED RE□□ORA□ION AND □OP OF CON□OLIDA□ION AREA CAP GRADE□

ARCADIS Project No.
HA100254.0000.00000

Date
03-24-2016

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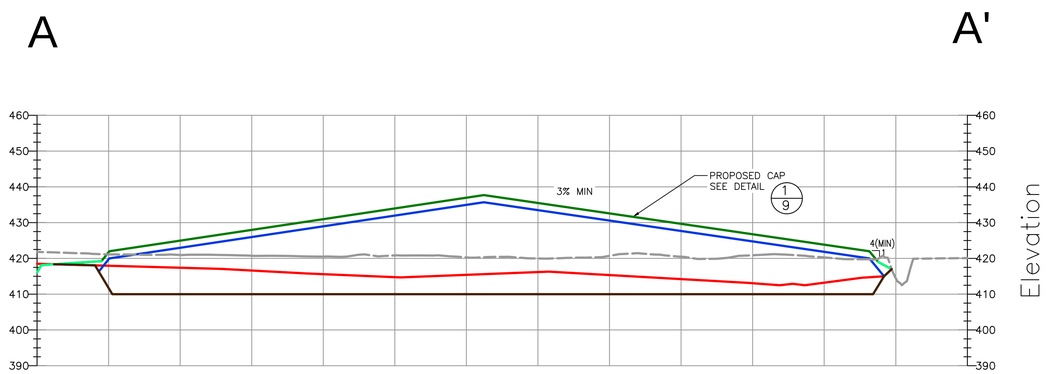
HORIZONTAL SCALE 1:1
SCALE IN FEET

0 20 40
VERTICAL SCALE 5:1
SCALE IN FEET

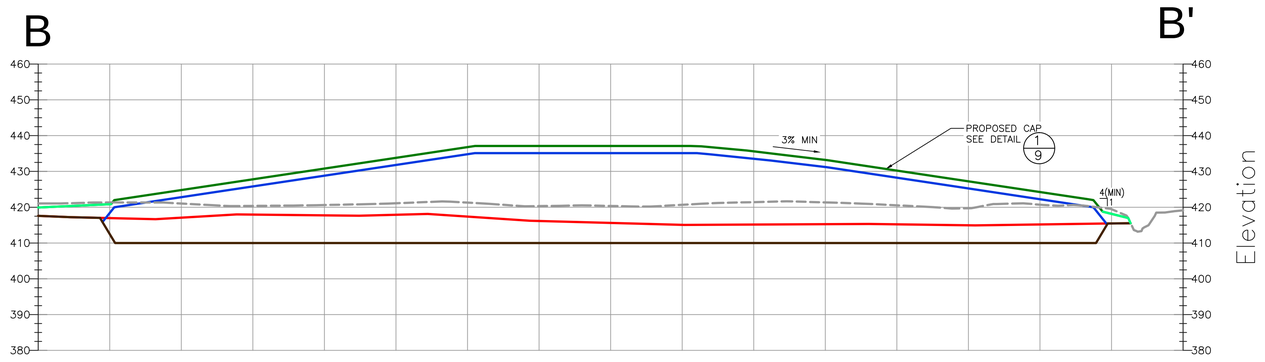
PROFILE VIEW OF SECTION 1/8



LEGEND

- CAP
- TOP OF CONSOLIDATED SLAG MATERIAL
- EXISTING GROUND
- EXISTING BOTTOM OF SLAG
- BORROW EXCAVATION/BOTTOM OF CONSOLIDATION AREA
- RESTORATION GRADES

PROFILE VIEW OF SECTION 2/8



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Professional Engineer's No.

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Designed by	Drawn by	Checked by
	MJC	JWH

ARCADIS

ARCADIS U.S., INC.

CRO□□ □EC□ION□

ARCADIS Project No.
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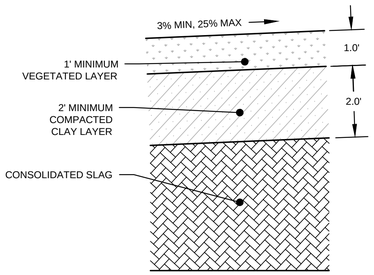

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1 / 9

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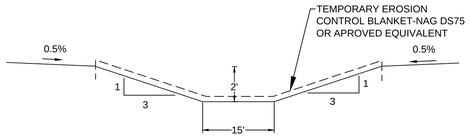
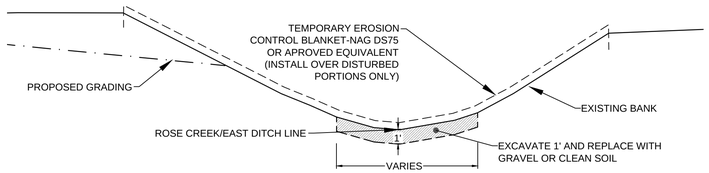


□□PICAL PROPO□ED DI□CH DE□AIL

2 / 9

NOT TO SCALE



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4 / 9

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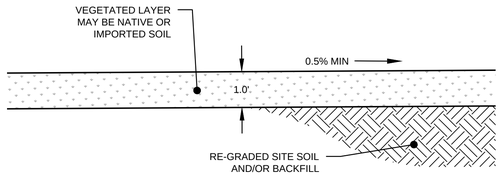

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5 / 9

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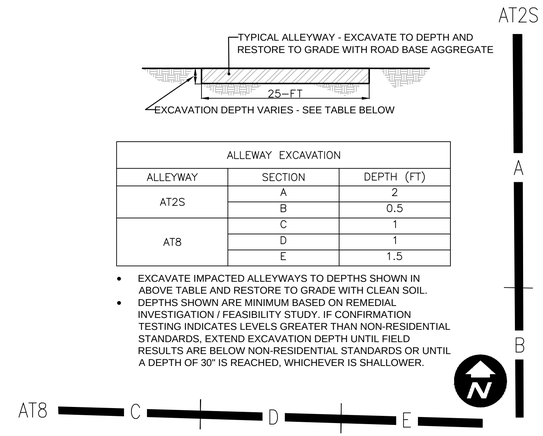


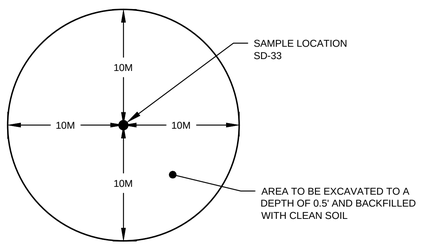
ALLEWAY EXCAVATION		
ALLEYWAY	SECTION	DEPTH (FT)
AT2S	A	2
	B	0.5
AT8	C	1
	D	1
	E	1.5

- EXCAVATE IMPACTED ALLEYWAYS TO DEPTHS SHOWN IN ABOVE TABLE AND RESTORE TO GRADE WITH CLEAN SOIL.
- DEPTHS SHOWN ARE MINIMUM BASED ON REMEDIAL INVESTIGATION / FEASIBILITY STUDY. IF CONFIRMATION TESTING INDICATES LEVELS GREATER THAN NON-RESIDENTIAL STANDARDS, EXTEND EXCAVATION DEPTH UNTIL FIELD RESULTS ARE BELOW NON-RESIDENTIAL STANDARDS OR UNTIL A DEPTH OF 30" IS REACHED, WHICHEVER IS SHALLOWER.

ALLEYWAY REMEDIATION DETAIL

3 / 9

NOT TO SCALE



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6 / 9

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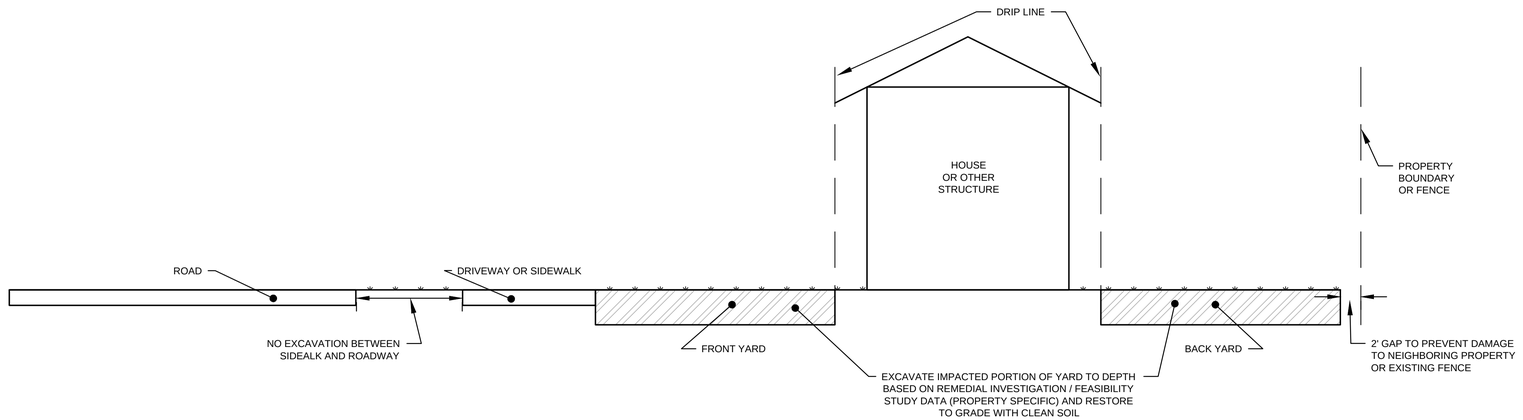

NOTES:

- IF CONFIRMATION TESTING INDICATES LEVELS GREATER THAN RESIDENTIAL STANDARDS, EXTEND EXCAVATION DEPTH UNTIL FIELD RESULTS ARE BELOW RESIDENTIAL STANDARDS OR UNTIL A DEPTH OF 30" IS REACHED, WHICHEVER IS SHALLOWER.
- NO EXCAVATION OF ROADS, SIDEWALKS, DRIVEWAYS, OR WITHIN THE DRIP LINE OF HOUSES OR OTHER BUILDINGS.

□□PICAL RE□IDEN□IAL REMEDIA□ION DE□AIL

7 / 9

NOT TO SCALE

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No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **JOHN HOLM**

Professional Engineer's No.:

State	Date Signed	Project Mgr.

Designed by	Drawn by	Checked by
	MAC	JWH

ARCADIS U.S., INC.

DE□AIL□

ARCADIS Project No.
HA100254.0000.00000

Date
3-24-2016

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APPENDIX B

Calculations

ARCADIS
Infrastructure, environment, buildings

Sheet _1__ of __5_ Date: 03/24/16

Project # HA100250.0000

Computed by: ZAC

Project Old American Zinc Site – Fairmont City

Checked by: JWH

Subject Earthwork Calculations

Approved by:

EARTHWORK CALCULATIONS

1.0 OBJECTIVE:

The remedial design for the Old American Zinc Plant Superfund Site in Fairmont City, Illinois has been prepared by ARCADIS U.S., Inc. As part of remediation efforts, slag material will be removed from the project site and off-site properties, the project site will be regraded, and the off-site properties will be returned to existing grades with clean material. The following report and calculations represent Arcadis' approximation of the earthwork that will be required for the proposed remediation.

2.0 GIVEN

1. The existing topography was provided to Arcadis by Sheppard, Morgan & Schwaab, Inc. in the CAD file titled "GOLD FIELDS MINING (439151) OLD AM ZINC TOPO.dwg" on March 3, 2016.

2. Boring samples indicating the bottom of slag elevations at different points across the site were provided by Entact.

3. The consolidation area clay liner will have a thickness of two feet, and the consolidation area vegetative soil layer will have a thickness of one foot.

3.0 ASSUMPTIONS

1. The bottom of slag elevations across the project site were approximated using known elevations at the Entact soil boring locations to develop a 3-dimensional surface for the entire site in AutoCAD Civil 3D. This method assumes that bottom of slag elevations for the entire site are consistent with the boring samples. Actual depths to the bottom of the slag material shall be determined in the field.

2. Two feet of contaminated soil will be excavated and replaced with clean soil in all off-site locations indicated on Sheet 6. It is assumed that 75% of the off-site remediated soil will be waste material, while the remaining 25% will be usable as a source of borrow soil.

3. The existing ditches/creeks requiring remediation have an approximate average bottom width of 5 feet.

4. It is assumed that 30% of the existing soil stockpile at the project site will be waste material, while the remaining 70% will be usable as a source of borrow soil.

4.0 CALCULATIONS AND SUMMARY

The results of the earthwork analysis are summarized in the table at the bottom of this section. The following text describes the methods and calculations used to determine the quantities for each item in the table.

Item A – The existing topography surface was compared with the surface representing the bottom of slag elevations in AutoCAD Civil 3D to determine the difference in volume between the two surfaces. This volume is the on-site material to be excavated. Items B, E, and Q were then subtracted from this difference in volume to determine the Item A volume.

Item B – The volume of the existing on-site slag stockpiles were determined in AutoCAD Civil 3D.

Item C – The area of the properties requiring remediation as shown in Sheet 6 of the plan set were determined in AutoCAD Civil 3D. This total area was then multiplied by a depth of two feet to determine an approximate volume of off-site material requiring remediation. 75% of this volume is assumed to be waste material.

Item D – The total length of ditches requiring remediation was determined to be 3,560 feet in AutoCAD Civil 3D. This value was multiplied by a depth of 1 foot and an approximate average bottom width of 5 feet to determine the volume.

Item E - The volume of the existing on-site soil stockpile was determined in AutoCAD Civil 3D. 30% of this volume is assumed to be waste material.

Item F – This volume is the sum of Items A through E.

Item G - The proposed top of waste surface was compared with the proposed excavation surface in AutoCAD Civil 3D to determine the difference in volume between the two surfaces. This volume is the repository area capacity.

Item H – This volume is Item G minus Item F.

Item I – The area of the consolidation area was determined in AutoCAD Civil 3D. This area was multiplied by a thickness of two feet to determine the clay liner volume

Item J - The area of the consolidation area was determined in AutoCAD Civil 3D. This area was multiplied by a thickness of one foot to determine the volume of the vegetative soil layer.

Item K – This volume is the sum of Items I and J.

Item L - The proposed restoration surface was compared with the proposed excavation surface in AutoCAD Civil 3D for the entire site, excluding the consolidation area, to determine the difference in volume between the two surfaces. Item L is the portion of this volume where restoration surface grades are below excavation surface grades.

Item M - The proposed restoration surface was compared with the proposed excavation surface in AutoCAD Civil 3D for the entire site excluding the consolidation area to determine the difference in volume between the two surfaces. Item M is the portion of this volume where restoration surface grades are above excavation surface grades.

Item N – This volume is Item M minus Item L.

Item O – This Volume is the sum of Items K, N, and D.

Item P - The proposed excavation surface was compared with the surface representing the bottom of slag elevations in AutoCAD Civil 3D for the consolidation area only. This comparison was used to determine the difference in volume between the two surfaces. This volume is the clay borrow excavation (below repository) volume.

Item Q - The volume of the existing on-site soil stockpile was determined in AutoCAD Civil 3D. 70% of this volume is assumed to be useable capping material.

Item R – This volume is the sum of Items P and Q.

Item S - The area of the properties requiring remediation as shown in Sheet 6 of the plan set were determined in AutoCAD Civil 3D. This total area was then multiplied by a depth of two feet to determine an approximate volume of off-site material requiring remediation. 25% of this volume is assumed to be useable capping material.

Item T – This volume is the result of Item O minus Items R and S.

Item U – This volume is the sum of Items C and S.

ARCADIS
Infrastructure, environment, buildings

Sheet _5__ of __5_ Date: 03/24/16

Project # HA100250.0000

Computed by: ZAC

Project Old American Zinc Site – Fairmont City

Checked by: JWH

Subject Earthwork Calculations

Approved by:

EARTHWORK SUMMARY			
Item	**SOURCE MATERIALS**		
A	ON-SITE MATERIAL, EXCLUSIVE OF SLAG PILES	712,554	CY
B	SLAG PILES	33,414	CY
C	UNUSABLE MATERIAL FROM OFF-SITE PROPERTIES (75% OF OFF-SITE MATERIAL)	42,889	CY
D	1FT DITCH EXCAVATION	660	CY
E	30% OF SOIL STOCKPILE	5,690	CY
F	*TOTAL SLAG/IMPACTED SOILS*	*795,207*	*CY*
	REPOSITORY VOLUME		
G	REPOSITORY AREA CAPACITY	853,300	CY
H	ADDITIONAL AVAILABLE CAPACITY	58,093	CY
	REQUIRED SOIL CAP VOLUME		
I	-2FT CLAY LINER	111,862	CY
J	-1FT VEGETATIVE SOIL	55,913	CY
K	*TOTAL CAP VOLUME*	*167,775*	*CY*
	REGRADING VOLUME		
L	RESTORATION GRADING (CUT)	19,185	CY
M	RESTORATION GRADING (FILL)	286,997	CY
N	RESTORATION GRADING (NET FILL)	267,812	CY
	TOTAL SOIL REQUIRED (FACILITY AREA)		
O	RESTORATION GRADING AND CAPPING	436,247	CY
	ON-SITE BORROW SOILS		
P	CLAY BORROW EXCAVATION (BELOW REPOSITORY)	333,140	CY
Q	SOIL STOCKPILE ASSUME 70% AVAILABLE BORROW	13,276	CY
R	*TOTAL AVAILABLE ON-SITE BORROW SOIL*	*346,416*	*CY*
	BORROW SOILS FROM EXCAVATED OFF-SITE PROPERTIES		
S	USABLE MATERIAL FROM OFF-SITE PROPERTIES (25% OF OFF-SITE MATERIAL)	14,296	CY
	ADDITIONAL SOIL REQUIRED		
T	RESTORATION GRADING	75,535	CY
U	CLEAN SOIL TO BE HAULED TO OFF-SITE PROPERTIES *	57,185	CY

ARCADIS
Infrastructure, environment, buildings

Sheet _1__ of __6_ Date: 03/22/16

Project # HA100250.0000

Computed by: ZAC

Project Old American Zinc Site – Fairmont City

Checked by: JWH

Subject Storm Water Calculations

Approved by:

STORM WATER CALCULATIONS

1.0 OBJECTIVE:

The remedial design for the Old American Zinc Plant Superfund Site in Fairmont City, Illinois has been prepared by ARCADIS U.S., Inc. As part of remediation efforts, slag material will be removed from the project site and the project site will be regraded with a grassed meadow final cover outside of the existing pavement and structures to remain in place. Storm water runoff at the site will be directed via sheet flow to storm water conveyance channels that ultimately drain to existing channels and storm sewer networks exiting the site. The following report and calculations demonstrate the design of the storm water conveyance channels.

The objectives of the storm water calculations are as follows:

1. Estimate the storm water runoff reaching each proposed storm water conveyance channel during the 25-year and 100-year/24-hour rainfall events.
2. Determine the peak water surface elevations within each storm water conveyance channel for the 25- and 100-year/24-hour rainfall events.
3. Size the channels to adequately convey runoff from the 25-year/24-hour storm event without overtopping and determine the extents of storm water overtopping the conveyance channels during the 100-year/24-hour storm event.
4. Determine an adequate liner for each channel, using the 25-year/24-hour peak flow rates and channel design information.

2.0 GIVEN

1. Precipitation depths for the 25-year, and 100-year/24-hour storm events are 5.54” and 7.65” respectively. (Refer to Appendix A - NOAA Rainfall Depth Chart)

2. The existing channel in the southern portion of the project site (Channel 4) has a varying depth, averaging approximately 4.5 feet, with 2.5:1 side slopes, and a varying bottom width averaging approximately 2 feet. This channel is nearly flat and exits the site at an approximate elevation of 412.00 at the southwest corner of the facility boundary.

3.0 ASSUMPTIONS

1. The Hydrologic Soil Group for the site area is D. Both Hydrologic Soil Group D and B/D soils surround the project site which is considered “urban land” according to the USDA Web Soil Survey. Since urban land is not assigned a Hydrologic Soil Group and D soils are present in the area of the project site, D soils were assumed for post-development land covers to be conservative.

2. A Curve Number of 84 (fair grass) was assumed for areas of proposed final cover. A Curve Number of 98 was assumed for all impervious areas.

3. A maximum sheet flow length of 100 feet was applied.

4. All channels were assumed to have a Manning's Number of .022 (earth, clean and straight per TR-55).

4.0 PROCEDURE

The SCS Storm Distribution method in the HydroCAD 10.00 modeling program was used to estimate the runoff hydrographs produced by the 25-year/24-hr, and 100-year/24-hr storm events for Channels 1-6. The Channel Drainage Area Map is located in Appendix B. The HydroCAD program outputs are located in Appendix C and Appendix D. The following is a description of the calculation procedure.

1. The design storm precipitations were obtained from the Precipitation Frequency Atlas of the United States National Oceanic & Atmospheric Administration (NOAA). The Point Precipitation Frequency Estimates for the NOAA observation site located closest to the Kanawha River Plant were utilized in the design calculations (See Appendix A).

2. The drainage areas, land cover types, and times of concentration for each channel were delineated using AutoCAD. See Appendix A for a Channel Drainage Area Map.

3. The drainage areas were input into HydroCAD 10.00 using the curve numbers noted in Section 2.0 above. The Manning's numbers for each surface along the time of concentration paths were determined using TR-55 standard values. The appropriate flow lengths, slopes, and Manning's numbers were input into HydroCAD 10.00 for the longest flow paths. Channels were modeled as reaches in HydroCAD 10.00 where necessary to appropriately model all storm water runoff reaching each channel. Peak flow rates for each sub-basin were then generated by HydroCAD 10.00. See Appendices C and D for the 25-year and 100-year/24-hour storm event HydroCAD 10.00 outputs respectively.

4. The peak flow rates were input along with channel section and profile information into the AutoDesk Hydraflow Express software to determine maximum water depths within the proposed and existing channels. See Appendices E and F for the 25-year and 100-year/24-hour storm event AutoDesk Hydraflow Express outputs respectively. Typical channel sections are shown in the remedial design plan sheets.

5. The maximum water depths were then used to determine the necessary depth of each channel to convey the 10-year/24-hour storm event without overtopping and to determine the extents of the overtopping of a 100-year storm event.

6. Using the final channel design dimensions and peak flow rate information as input data, the North American Green ECMDS software was then used to determine an adequate liner for the proposed worst case conditions.

4.0 DESIGN CRITERIA EVALUATION

The following table summarizes the program outputs noted above in Section 3.0.

Channel Design Summary				
Channel No.	Peak Runoff Rate (cfs)		Water Depth (ft)	
	25-yr/24-hr	100-yr/24-hr	25-yr/24-hr	100-yr/24-hr
1	79.96	119.98	1.37	1.73
2	67.69	102.40	1.24	1.58
3	102.64	154.89	1.59	2.00
4	191.13	303.25	4.25	5.13
5	97.40	146.84	1.53	1.94
6	75.62	113.99	1.33	1.68

Using the North American Green Erosion Control Materials Design Software the conclusion was made that North American Green DS75 liner will remain stable during the worst-case 25-year/24-hour storm event peak rate for the proposed Channels 1,2,3,5, and 6 (102.64 cfs) and for the existing Channel 4 (191.13 cfs).

5.0 CONCLUSION

The proposed channels (Channels 1, 2, 3, 5, and 6) will be constructed to a depth of 2 feet. Therefore, all proposed storm water conveyance channels will safely pass the 25-year/24-hour storm event without overtopping. All proposed channels also safely pass the 100-year/24-hour storm event without overtopping. The existing channel (Channel 4) will safely pass the 25-year/24-hour storm event without overtopping, but will overtop during a 100-year/24-hour storm event in some areas. The ponding elevation and footprint above Channel 4 during a 100-year/24-hour storm event is minimal (approximately 12% of the overall peak flow) and should not result in any significant issues on-site. Channels 1-6 will be lined with North American Green DS75 liner or an approved equivalent.

6.0 REFERENCES

1. Precipitation Frequency Atlas of the United States NOAA Atlas 14, Volume 2, Version 3, NOAA, National Weather Service, 2004.

2. HydroCAD Version 10.00, Applied Micro Computer Systems, 2016.

3. Web Soil Survey Interactive Map, USDA, Accessed March 2016.

4. Erosion Control Material Design Software, North American Green, Accessed March 2016.

5. Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55), Second Edition, United States Department of Agriculture and Natural Resources Conservation Service, Conservation Engineering Division, June 1986.

Appendix A

NOAA Data

NOAA Atlas 14, Volume 2, Version 3
Location name: East Saint Louis, Illinois, US*
Latitude: 38.6472°, Longitude: -90.0978°
Elevation: 424 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.398 (0.364-0.438)	0.472 (0.431-0.519)	0.562 (0.512-0.618)	0.634 (0.575-0.696)	0.727 (0.658-0.797)	0.802 (0.723-0.879)	0.877 (0.788-0.961)	0.959 (0.857-1.05)	1.07 (0.952-1.18)	1.17 (1.03-1.28)
10-min	0.619 (0.565-0.681)	0.738 (0.673-0.811)	0.874 (0.795-0.961)	0.978 (0.888-1.08)	1.11 (1.01-1.22)	1.22 (1.10-1.33)	1.32 (1.19-1.45)	1.43 (1.28-1.57)	1.58 (1.40-1.73)	1.70 (1.50-1.86)
15-min	0.759 (0.693-0.834)	0.902 (0.823-0.991)	1.07 (0.977-1.18)	1.20 (1.09-1.32)	1.37 (1.24-1.51)	1.51 (1.36-1.65)	1.64 (1.47-1.80)	1.78 (1.59-1.95)	1.97 (1.75-2.16)	2.12 (1.87-2.33)
30-min	1.00 (0.916-1.10)	1.21 (1.10-1.33)	1.47 (1.34-1.62)	1.67 (1.52-1.84)	1.94 (1.76-2.13)	2.15 (1.94-2.36)	2.37 (2.13-2.60)	2.60 (2.32-2.84)	2.92 (2.59-3.19)	3.18 (2.80-3.49)
60-min	1.23 (1.12-1.35)	1.48 (1.35-1.63)	1.84 (1.68-2.03)	2.13 (1.93-2.34)	2.52 (2.28-2.76)	2.83 (2.55-3.11)	3.17 (2.84-3.47)	3.53 (3.15-3.86)	4.04 (3.58-4.42)	4.47 (3.94-4.90)
2-hr	1.45 (1.32-1.60)	1.75 (1.59-1.93)	2.19 (1.98-2.41)	2.55 (2.30-2.80)	3.08 (2.77-3.37)	3.54 (3.17-3.88)	4.06 (3.61-4.44)	4.64 (4.11-5.07)	5.54 (4.86-6.04)	6.33 (5.52-6.91)
3-hr	1.55 (1.41-1.71)	1.86 (1.70-2.06)	2.33 (2.12-2.57)	2.73 (2.47-3.00)	3.32 (2.99-3.64)	3.83 (3.44-4.20)	4.42 (3.95-4.83)	5.08 (4.52-5.55)	6.11 (5.39-6.67)	7.03 (6.15-7.69)
6-hr	1.84 (1.68-2.03)	2.22 (2.03-2.45)	2.77 (2.53-3.05)	3.24 (2.94-3.56)	3.94 (3.56-4.31)	4.56 (4.10-4.99)	5.26 (4.70-5.74)	6.06 (5.38-6.61)	7.30 (6.41-7.96)	8.41 (7.33-9.18)
12-hr	2.20 (2.01-2.43)	2.64 (2.41-2.92)	3.28 (2.98-3.62)	3.82 (3.46-4.21)	4.62 (4.17-5.08)	5.33 (4.79-5.85)	6.12 (5.47-6.71)	7.02 (6.24-7.69)	8.42 (7.41-9.22)	9.67 (8.44-10.6)
24-hr	2.60 (2.38-2.89)	3.12 (2.85-3.46)	3.85 (3.52-4.27)	4.51 (4.10-4.98)	5.54 (5.00-6.12)	6.50 (5.82-7.16)	7.65 (6.78-8.41)	9.01 (7.89-9.91)	11.2 (9.65-12.4)	13.3 (11.2-14.7)
2-day	3.00 (2.74-3.32)	3.59 (3.28-3.98)	4.45 (4.06-4.94)	5.21 (4.73-5.77)	6.41 (5.78-7.09)	7.52 (6.72-8.31)	8.83 (7.80-9.76)	10.4 (9.07-11.5)	12.9 (11.1-14.4)	15.2 (12.8-17.0)
3-day	3.20 (2.93-3.55)	3.85 (3.52-4.26)	4.76 (4.35-5.28)	5.57 (5.06-6.17)	6.84 (6.17-7.56)	8.01 (7.16-8.86)	9.38 (8.30-10.4)	11.0 (9.63-12.2)	13.6 (11.7-15.2)	16.1 (13.6-18.0)
4-day	3.41 (3.12-3.78)	4.10 (3.75-4.54)	5.08 (4.64-5.63)	5.93 (5.39-6.56)	7.27 (6.56-8.04)	8.50 (7.60-9.41)	9.94 (8.80-11.0)	11.6 (10.2-12.9)	14.4 (12.4-16.1)	16.9 (14.3-19.0)
7-day	4.01 (3.69-4.39)	4.81 (4.42-5.27)	5.88 (5.40-6.44)	6.78 (6.21-7.42)	8.16 (7.42-8.94)	9.39 (8.49-10.3)	10.8 (9.69-11.8)	12.4 (11.0-13.6)	14.9 (13.1-16.4)	17.3 (15.0-19.1)
10-day	4.54 (4.19-4.94)	5.44 (5.02-5.92)	6.64 (6.11-7.22)	7.64 (7.01-8.29)	9.16 (8.36-9.95)	10.5 (9.54-11.4)	12.0 (10.8-13.1)	13.8 (12.3-15.0)	16.5 (14.5-18.1)	18.9 (16.5-20.8)
20-day	6.22 (5.79-6.71)	7.43 (6.90-8.01)	8.88 (8.25-9.57)	10.1 (9.32-10.8)	11.8 (10.9-12.7)	13.3 (12.2-14.3)	14.9 (13.6-16.0)	16.7 (15.1-18.0)	19.3 (17.4-20.9)	21.6 (19.3-23.5)
30-day	7.64 (7.13-8.18)	9.07 (8.47-9.72)	10.7 (10.0-11.5)	12.0 (11.2-12.9)	13.9 (12.9-14.9)	15.5 (14.4-16.7)	17.3 (15.9-18.5)	19.1 (17.5-20.6)	21.9 (19.9-23.7)	24.2 (21.8-26.3)
45-day	9.52 (8.94-10.1)	11.3 (10.6-12.0)	13.3 (12.4-14.1)	14.8 (13.9-15.8)	17.0 (15.9-18.1)	18.9 (17.6-20.1)	20.9 (19.4-22.3)	23.0 (21.3-24.6)	26.2 (23.9-28.0)	28.7 (26.1-30.9)
60-day	11.1 (10.5-11.8)	13.2 (12.4-14.0)	15.4 (14.5-16.3)	17.1 (16.1-18.2)	19.6 (18.4-20.8)	21.7 (20.2-23.1)	23.9 (22.2-25.4)	26.3 (24.3-28.1)	29.7 (27.3-31.8)	32.5 (29.7-35.0)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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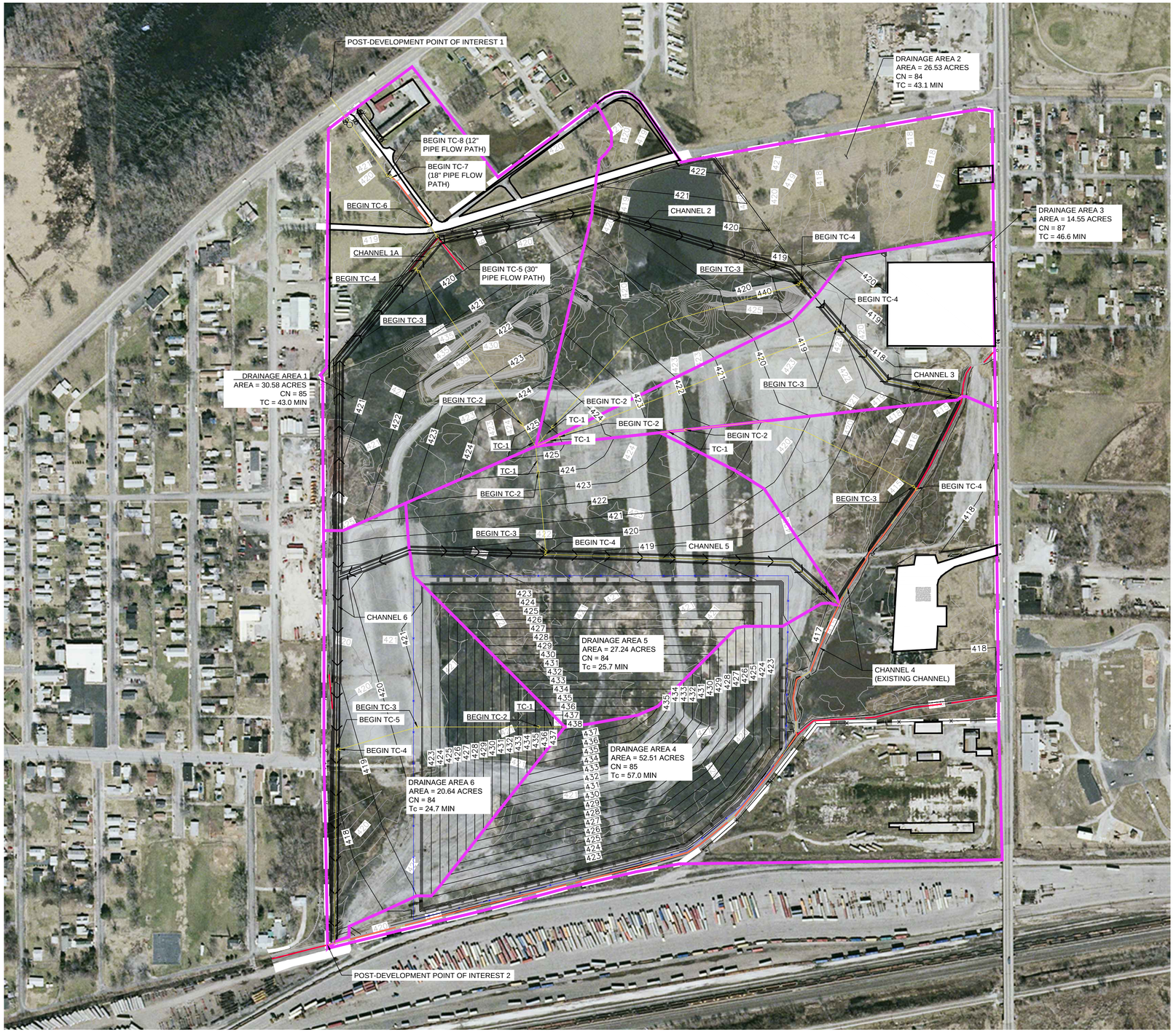
PF graphical

Appendix B

Channel Drainage Area Map



0 200 400
SCALE IN FEET

LEGEND

- EXISTING CONTOUR
- FACILITY AREA BOUNDARY
- EXISTING DITCH LINE
- EXISTING FENCE LINE
- EXISTING CULVERT
- POST-DEVELOPMENT DRAINAGE AREA
- POST-DEVELOPMENT TIME OF CONCENTRATION PATH
- PROPOSED DITCH CENTERLINE
- PROPOSED CONSOLIDATION AREA
- PROPOSED FENCE LINE
- PROPOSED CONTOUR

SCALE(S) AS INDICATED

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:

USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: JOHN HOLM
Professional Engineer's No.:

State	Date Signed	Project Mgr.
		RJK
Designed by	Drawn by	Checked by
	ZAC	JWH

ARCADIS U.S., INC.

CHANNEL DRAINAGE AREA MAP

ARCADIS Project No.
HA100254.0000.00000

Date
03-22-2016

ARCADIS
4665 CORNELL ROAD
SUITE 350
CINCINNATI, OHIO 45241
TEL. 513.860.8700

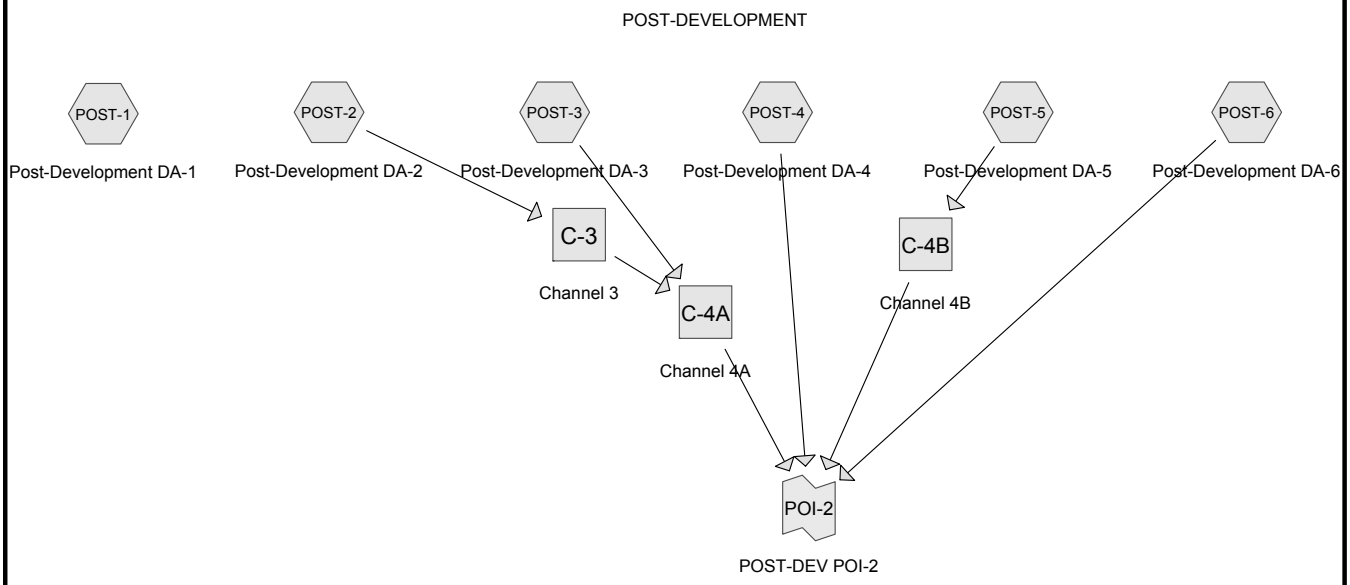
1 of 1

G:\LFR\Projects\HA100254.0000_Gold Fields_Remedial Design for Old American Zinc Superfund Site\Technical\Figures\Remedial Design\Remedial Design_Final_DRAFT\HA100254.0000_Remedial Design.dwg LAYOUT: POST HYD SAVED: 3/22/2016 4:25 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ----
PLOTTED: 3/22/2016 4:25 PM BY: CLARK, ZAC

Appendix C

HydroCAD Output:

25-year/24-hour Storm Event



Subcat Reach Pond Link

Routing Diagram for HA100254_Peak_Rate
Prepared by {enter your company name here}, Printed 3/22/2016

Time span=5.00-72.00 hrs, dt=0.05 hrs, 1341 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment POST-1: Post-Development Runoff Area=30.580 ac 6.31% Impervious Runoff Depth=3.87"
Flow Length=1,730' Tc=43.0 min CN=85 Runoff=79.96 cfs 9.863 af
↑ CHANNEL 1 FLOW

Subcatchment POST-2: Post-Development Runoff Area=26.530 ac 2.26% Impervious Runoff Depth=3.77"
Flow Length=1,318' Tc=43.1 min CN=84 Runoff=67.69 cfs 8.330 af
↑ CHANNEL 2 FLOW

Subcatchment POST-3: Post-Development Runoff Area=14.550 ac 20.82% Impervious Runoff Depth>4.08"
Flow Length=1,826' Tc=46.6 min CN=87 Runoff=37.68 cfs 4.945 af

Subcatchment POST-4: Post-Development Runoff Area=52.510 ac 4.06% Impervious Runoff Depth=3.87"
Flow Length=4,184' Tc=57.0 min CN=85 Runoff=112.46 cfs 16.936 af

Subcatchment POST-5: Post-Development Runoff Area=27.240 ac 0.00% Impervious Runoff Depth=3.77"
Flow Length=1,604' Tc=25.7 min CN=84 Runoff=97.40 cfs 8.553 af
↑ CHANNEL 5 FLOW

Subcatchment POST-6: Post-Development Runoff Area=20.640 ac 0.00% Impervious Runoff Depth=3.77"
Flow Length=1,631' Tc=24.7 min CN=84 Runoff=75.62 cfs 6.481 af
↑ CHANNEL 6 FLOW

Reach C-3: Channel 3 Avg. Flow Depth=1.80' Max Vel=1.98 fps Inflow=67.69 cfs 8.330 af
n=0.022 L=571.0' S=0.0005 '/' Capacity=165.84 cfs Outflow=66.12 cfs 8.330 af

Reach C-4A: Channel 4A Avg. Flow Depth=3.93' Max Vel=1.28 fps Inflow=102.64 cfs 13.275 af
n=0.022 L=3,535.0' S=0.0001 '/' Capacity=62.00 cfs Outflow=59.46 cfs 13.275 af
↑ CHANNEL 3 FLOW

Reach C-4B: Channel 4B Avg. Flow Depth=3.27' Max Vel=1.88 fps Inflow=97.40 cfs 8.553 af
n=0.022 L=2,601.0' S=0.0004 '/' Capacity=102.22 cfs Outflow=62.41 cfs 8.553 af

Link POI-2: POST-DEV POI-2 Inflow=191.13 cfs 45.245 af
Primary=191.13 cfs 45.245 af
↑ CHANNEL 4 FLOW

Total Runoff Area = 172.050 ac Runoff Volume = 55.108 af Average Runoff Depth = 3.84"
95.53% Pervious = 164.360 ac 4.47% Impervious = 7.690 ac

Summary for Subcatchment POST-1: Post-Development DA-1

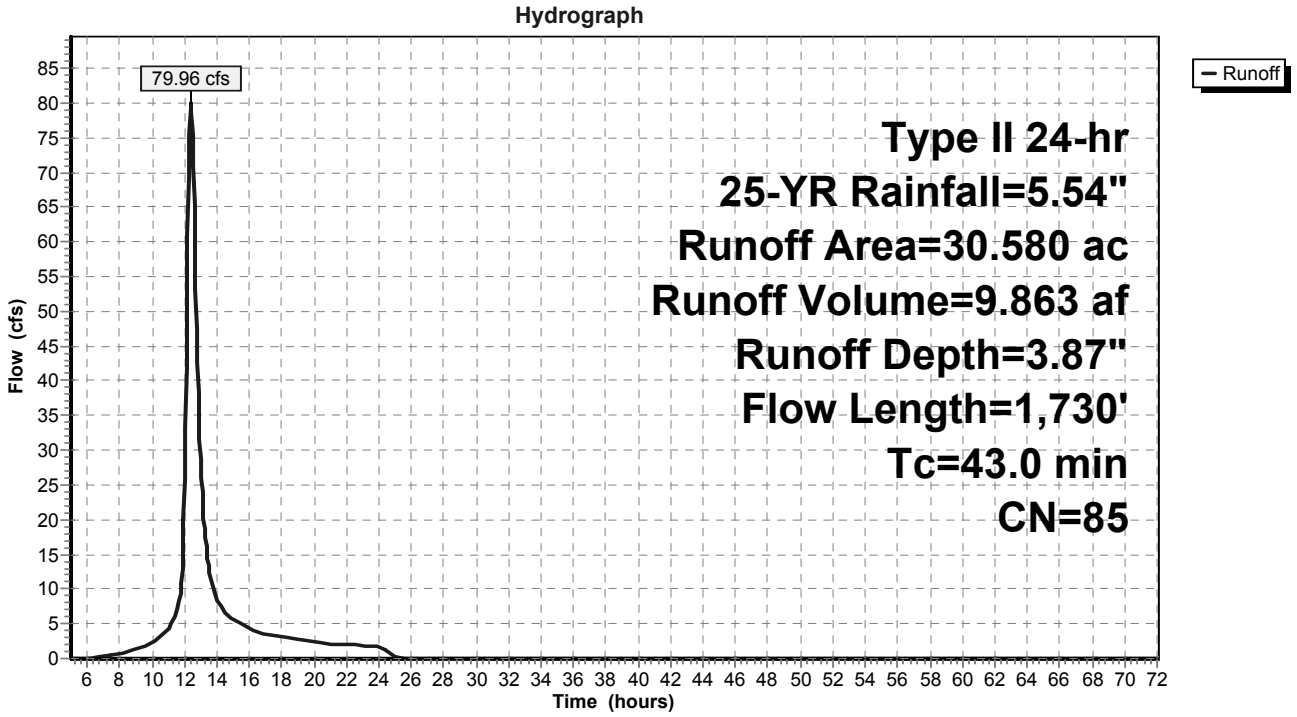
Runoff = 79.96 cfs @ 12.39 hrs, Volume= 9.863 af, Depth= 3.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=5.54"

Area (ac)	CN	Description
1.930	98	Paved parking, HSG D
28.650	84	50-75% Grass cover, Fair, HSG D
30.580	85	Weighted Average
28.650		93.69% Pervious Area
1.930		6.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.3	100	0.0080	0.07		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 1.00"
8.2	707	0.0080	1.44		**Shallow Concentrated Flow, Shallow Concentrated Flow** Unpaved Kv= 16.1 fps
0.0	16	0.5000	10.61		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
0.7	230	0.0020	5.14	323.57	**Trap/Vee/Rect Channel Flow, Channelized Flow** Bot.W=15.00' D=3.00' Z= 2.0 '/' Top.W=27.00' n= 0.022 Earth, clean & straight
0.9	54	0.0001	0.99	4.85	**Pipe Channel, 30" RCP Pipe Flow** 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011 Concrete pipe, straight & clean
5.9	232	0.0001	0.65	8.51	**Trap/Vee/Rect Channel Flow, Channelized Flow** Bot.W=0.00' D=2.00' Z= 2.5 & 4.0 '/' Top.W=13.00' n= 0.022 Earth, clean & straight
0.1	19	0.0260	4.98	8.81	**Pipe Channel, 18" CMP Pipe Flow** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.025 Corrugated metal
1.9	372	0.0200	3.34	2.62	**Pipe Channel, 12" CMP Pipe Flow** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.025 Corrugated metal
43.0	1,730	Total			

Subcatchment POST-1: Post-Development DA-1



Summary for Subcatchment POST-2: Post-Development DA-2

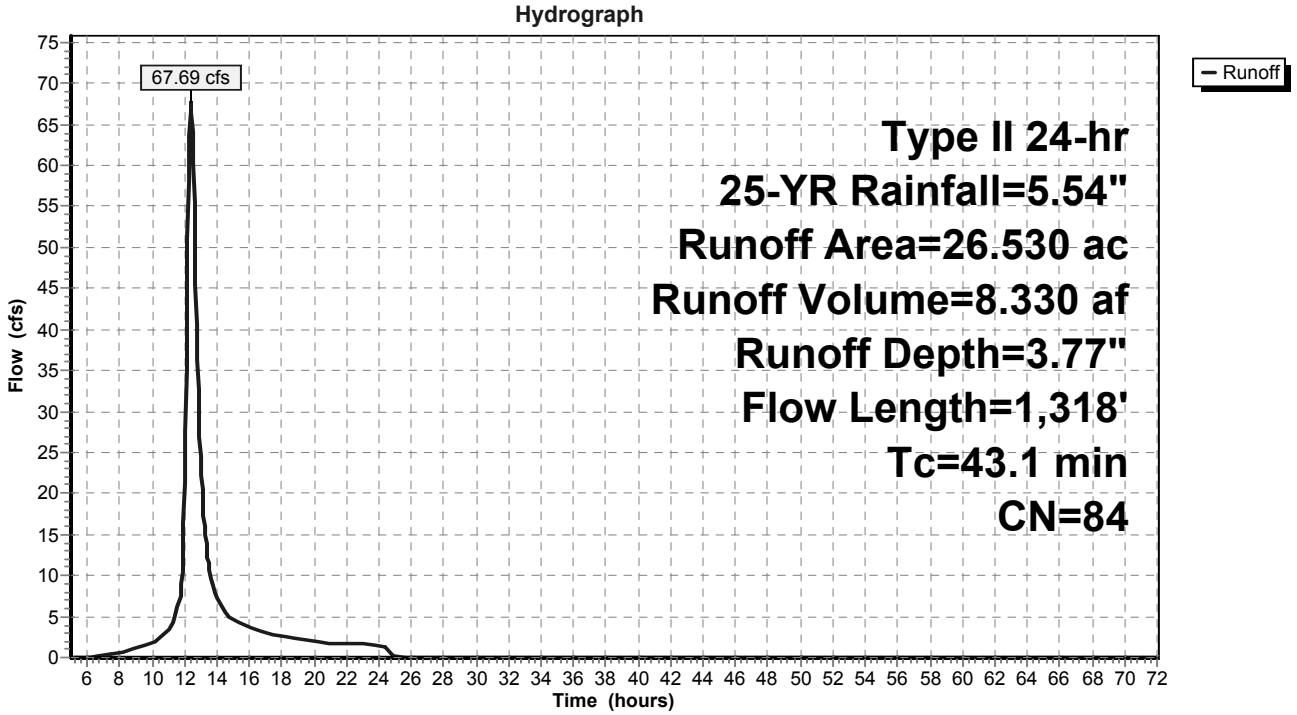
Runoff = 67.69 cfs @ 12.40 hrs, Volume= 8.330 af, Depth= 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=5.54"

Area (ac)	CN	Description
0.600	98	Paved parking, HSG D
25.930	84	50-75% Grass cover, Fair, HSG D
26.530	84	Weighted Average
25.930		97.74% Pervious Area
0.600		2.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.7	100	0.0070	0.06		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 1.00"
16.2	1,130	0.0060	1.16		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
0.0	15	0.3330	8.66		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
0.2	73	0.0020	5.14	323.57	**Trap/Vee/Rect Channel Flow, Channelized Flow** Bot.W=15.00' D=3.00' Z= 2.0 '/' Top.W=27.00' n= 0.022 Earth, clean & straight
43.1	1,318	Total			

Subcatchment POST-2: Post-Development DA-2



Summary for Subcatchment POST-3: Post-Development DA-3

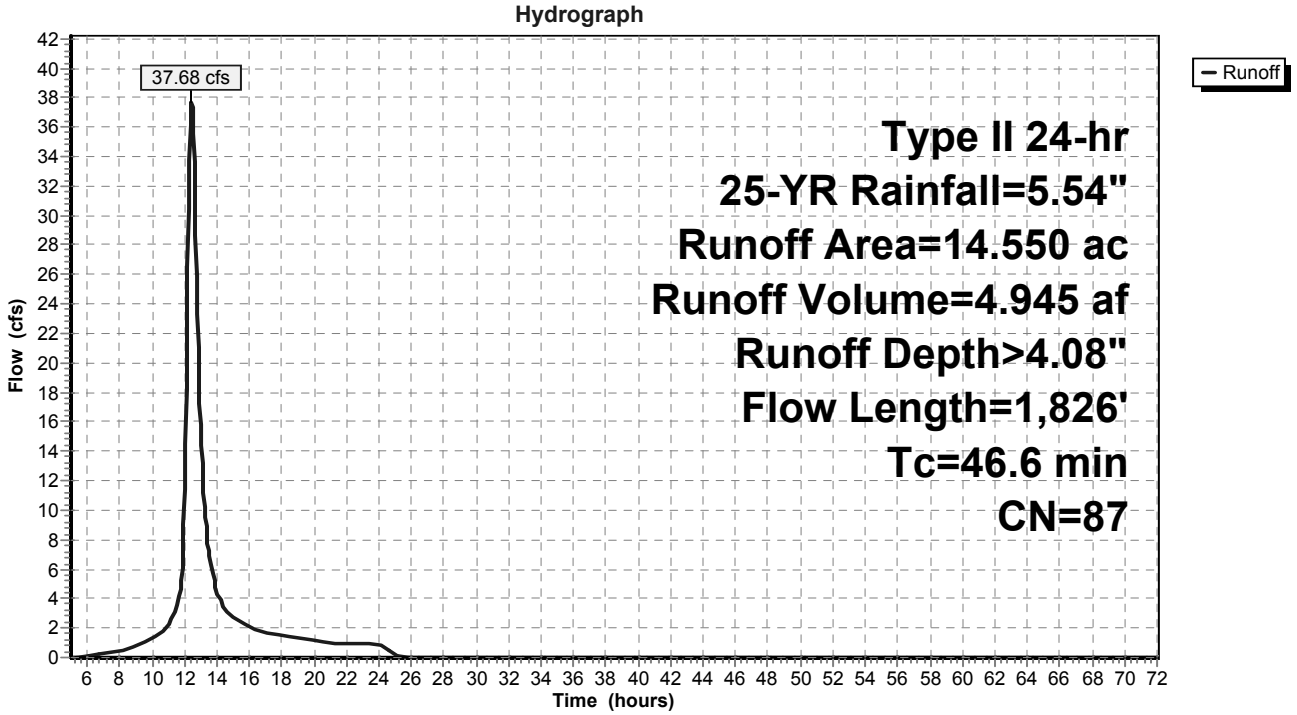
Runoff = 37.68 cfs @ 12.44 hrs, Volume= 4.945 af, Depth> 4.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=5.54"

Area (ac)	CN	Description
3.030	98	Paved parking, HSG D
11.520	84	50-75% Grass cover, Fair, HSG D
14.550	87	Weighted Average
11.520		79.18% Pervious Area
3.030		20.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.4	100	0.0060	0.06		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 1.00"
16.3	1,139	0.0060	1.16		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
0.0	16	0.3330	8.66		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
1.9	571	0.0020	5.14	323.57	**Trap/Vee/Rect Channel Flow, Channelized Flow** Bot.W=15.00' D=3.00' Z= 2.0 '/' Top.W=27.00' n= 0.022 Earth, clean & straight
46.6	1,826	Total			

Subcatchment POST-3: Post-Development DA-3



Summary for Subcatchment POST-4: Post-Development DA-4

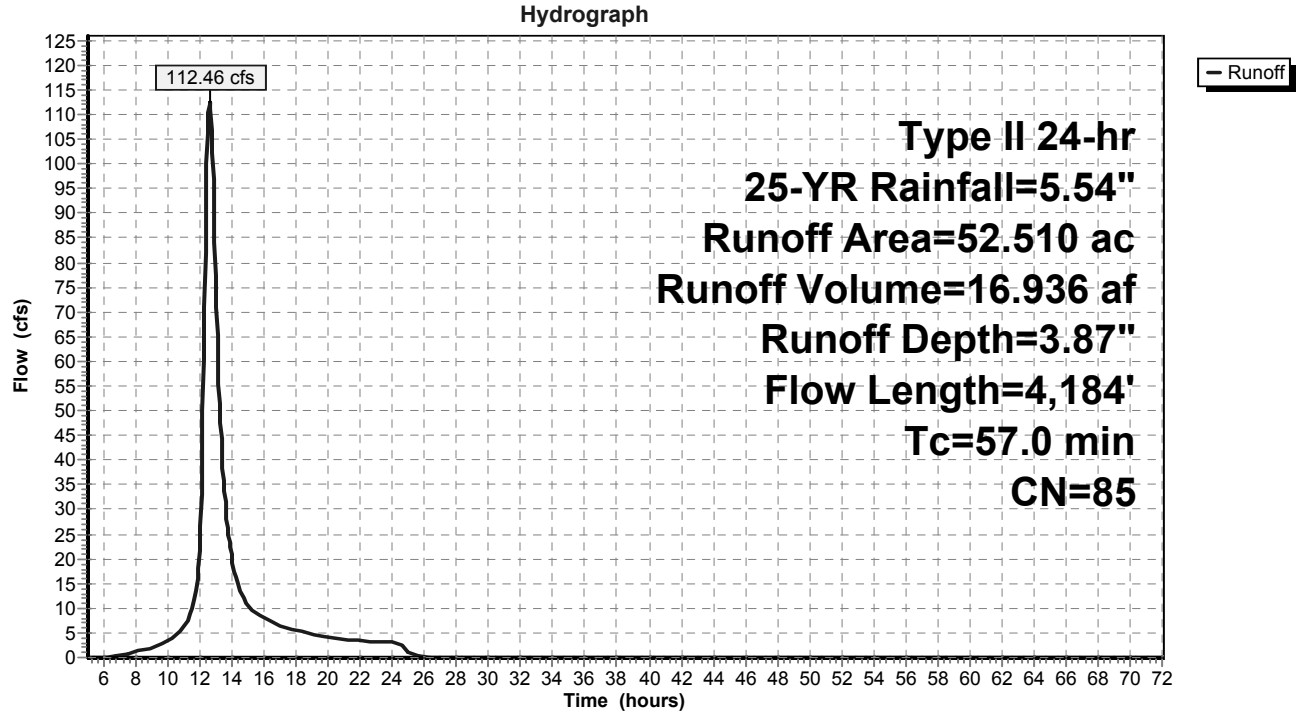
Runoff = 112.46 cfs @ 12.58 hrs, Volume= 16.936 af, Depth= 3.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=5.54"

Area (ac)	CN	Description
2.130	98	Paved parking, HSG D
50.380	84	50-75% Grass cover, Fair, HSG D
52.510	85	Weighted Average
50.380		95.94% Pervious Area
2.130		4.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.4	100	0.0060	0.06		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 1.00"
13.4	931	0.0060	1.16		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
0.0	15	0.3330	8.66		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
15.2	3,138	0.0010	3.43	164.86	**Trap/Vee/Rect Channel Flow, Channelized Flow** Bot.W=2.00' D=4.00' Z= 2.5 '/' Top.W=22.00' n= 0.022 Earth, clean & straight
57.0	4,184	Total			

Subcatchment POST-4: Post-Development DA-4



Summary for Subcatchment POST-5: Post-Development DA-5

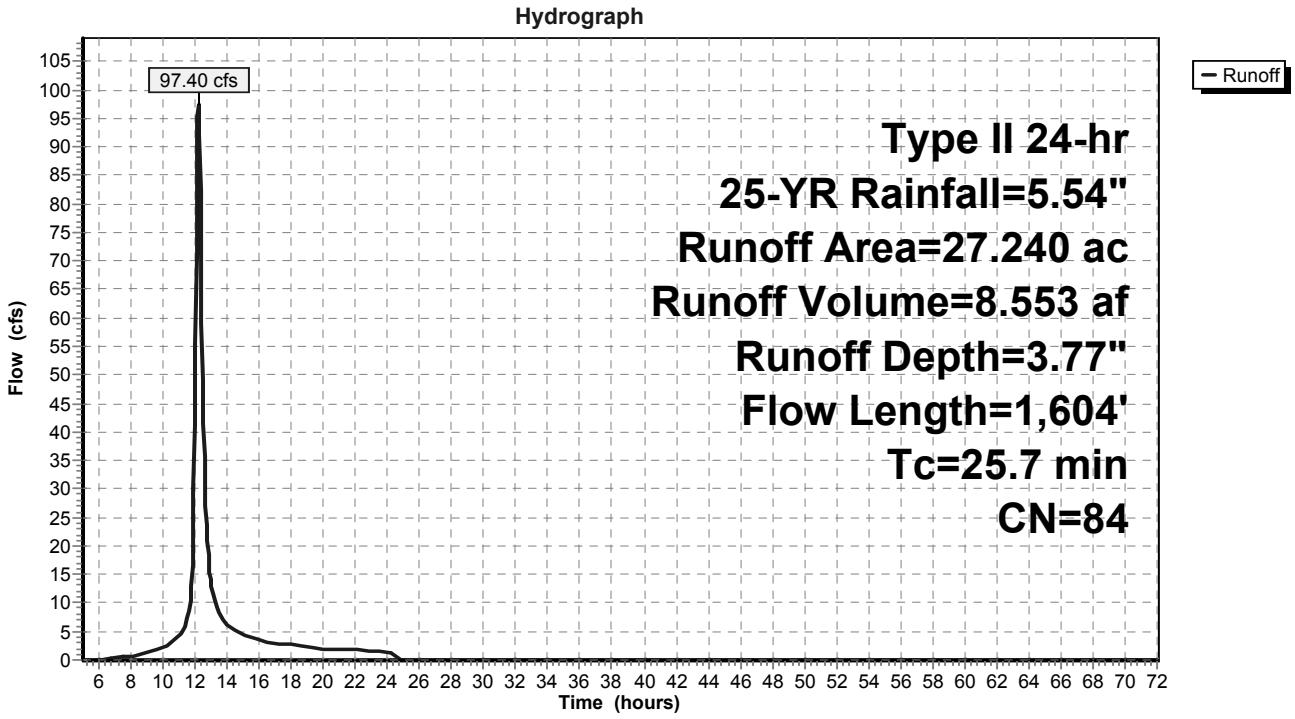
Runoff = 97.40 cfs @ 12.19 hrs, Volume= 8.553 af, Depth= 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=5.54"

Area (ac)	CN	Description
27.240	84	50-75% Grass cover, Fair, HSG D
27.240		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.2	100	0.0160	0.09		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 1.00"
2.6	301	0.0170	1.96		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
0.0	15	0.3330	8.66		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
3.9	1,188	0.0020	5.14	323.57	**Trap/Vee/Rect Channel Flow, Channelized Flow** Bot.W=15.00' D=3.00' Z= 2.0 '/' Top.W=27.00' n= 0.022 Earth, clean & straight
25.7	1,604	Total			

Subcatchment POST-5: Post-Development DA-5



Summary for Subcatchment POST-6: Post-Development DA-6

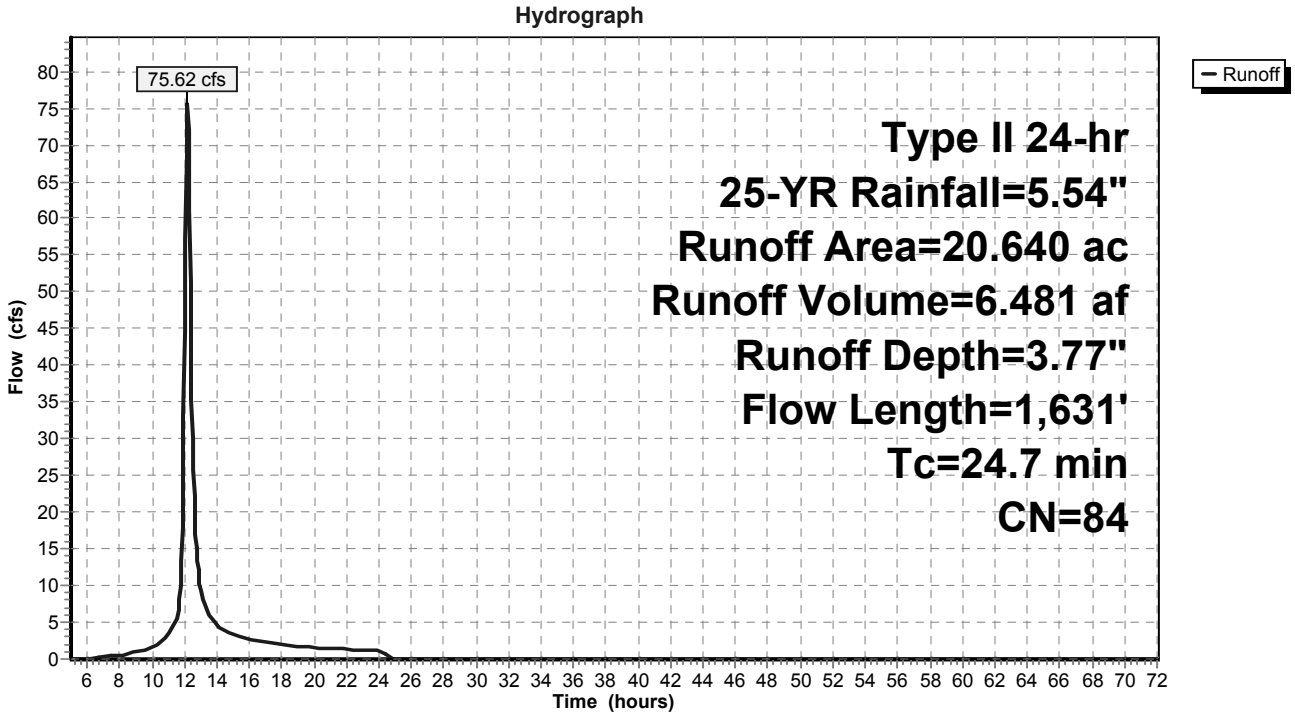
Runoff = 75.62 cfs @ 12.17 hrs, Volume= 6.481 af, Depth= 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=5.54"

Area (ac)	CN	Description
20.640	84	50-75% Grass cover, Fair, HSG D
20.640		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	100	0.0260	0.11		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 1.00"
2.9	465	0.0320	2.68		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
3.6	310	0.0090	1.42		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
0.0	13	0.3330	8.66		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
2.4	743	0.0020	5.14	323.57	**Trap/Vee/Rect Channel Flow, Channelized Flow** Bot.W=15.00' D=3.00' Z= 2.0 '/' Top.W=27.00' n= 0.022 Earth, clean & straight
24.7	1,631	Total			

Subcatchment POST-6: Post-Development DA-6



Summary for Reach C-3: Channel 3

Inflow Area = 26.530 ac, 2.26% Impervious, Inflow Depth = 3.77" for 25-YR event
Inflow = 67.69 cfs @ 12.40 hrs, Volume= 8.330 af
Outflow = 66.12 cfs @ 12.54 hrs, Volume= 8.330 af, Atten= 2%, Lag= 8.4 min

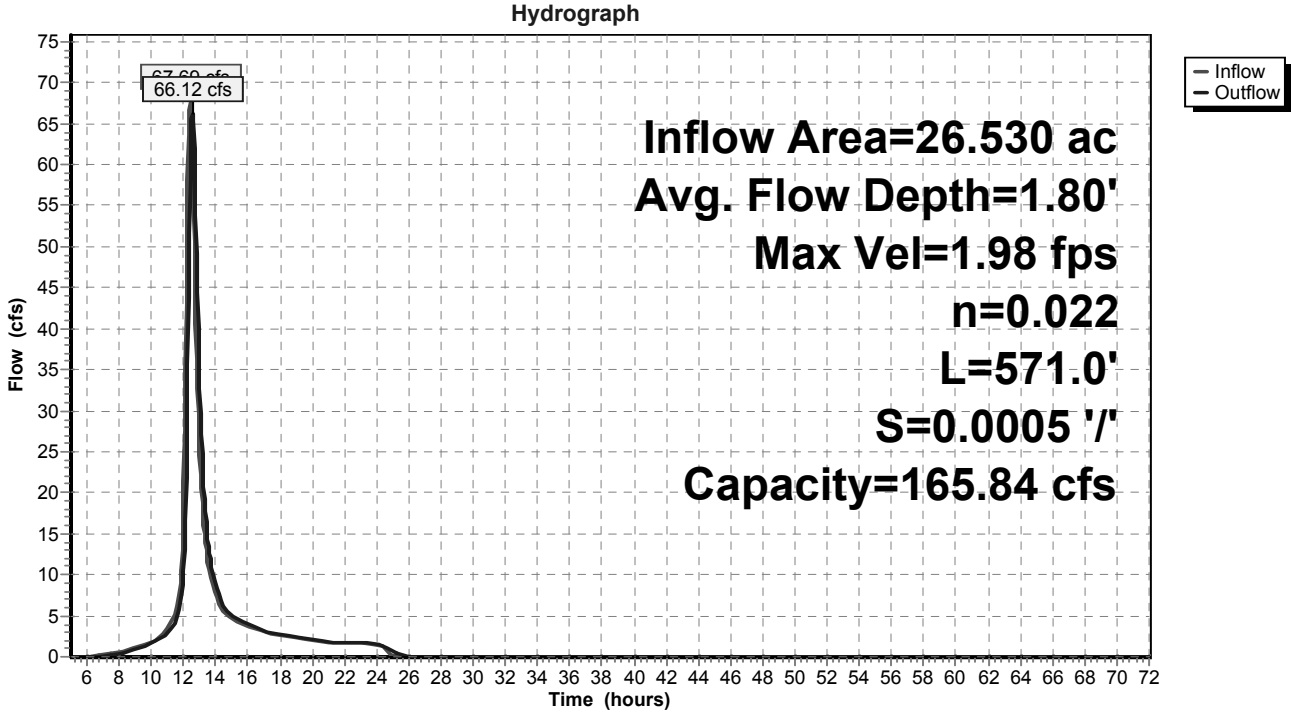
Routing by Stor-Ind+Trans method, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.98 fps, Min. Travel Time= 4.8 min
Avg. Velocity = 0.47 fps, Avg. Travel Time= 20.0 min

Peak Storage= 19,095 cf @ 12.46 hrs
Average Depth at Peak Storage= 1.80'
Bank-Full Depth= 3.00' Flow Area= 63.0 sf, Capacity= 165.84 cfs

15.00' x 3.00' deep channel, n= 0.022
Side Slope Z-value= 2.0 '/' Top Width= 27.00'
Length= 571.0' Slope= 0.0005 '/'
Inlet Invert= 415.40', Outlet Invert= 415.10'

‡

Reach C-3: Channel 3



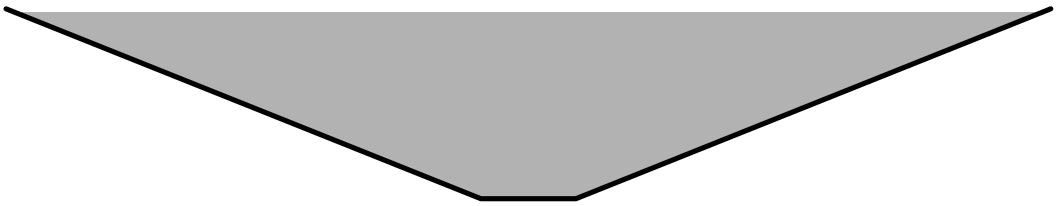
Summary for Reach C-4A: Channel 4A

Inflow Area = 41.080 ac, 8.84% Impervious, Inflow Depth > 3.88" for 25-YR event
Inflow = 102.64 cfs @ 12.51 hrs, Volume= 13.275 af
Outflow = 59.46 cfs @ 13.67 hrs, Volume= 13.275 af, Atten= 42%, Lag= 69.6 min

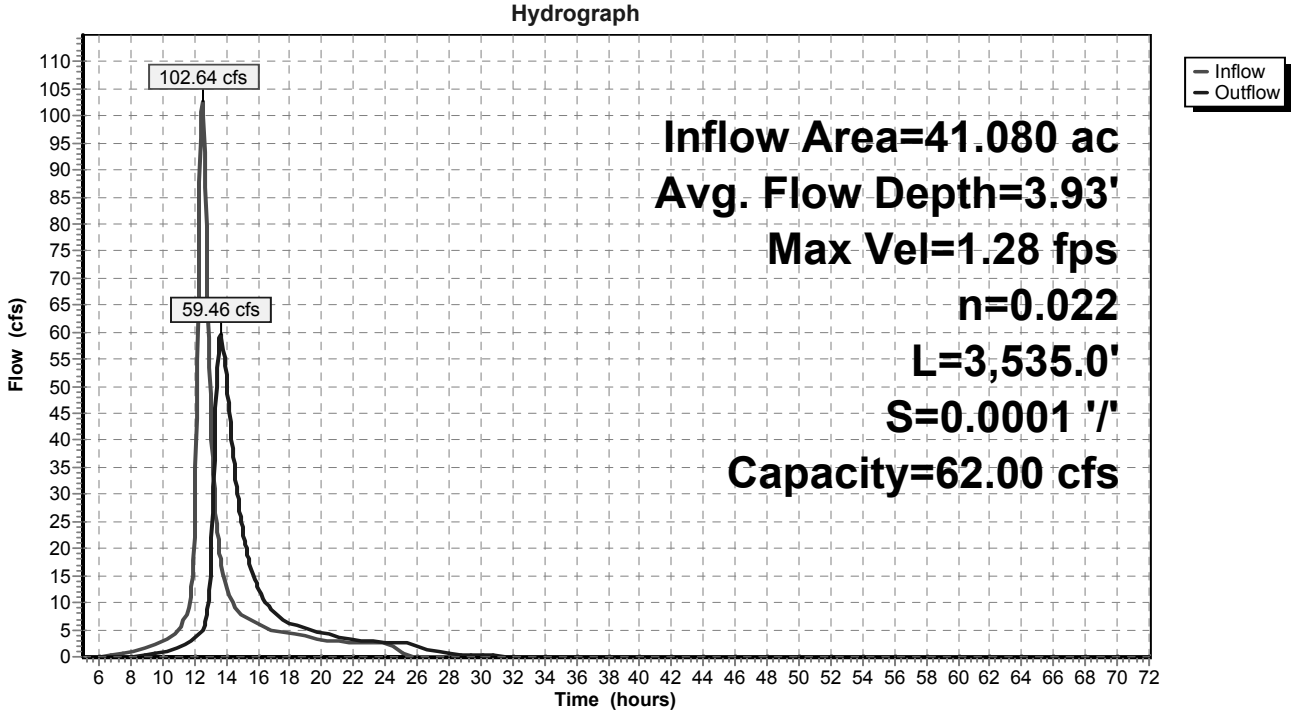
Routing by Stor-Ind+Trans method, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.28 fps, Min. Travel Time= 46.1 min
Avg. Velocity = 0.28 fps, Avg. Travel Time= 209.1 min

Peak Storage= 164,559 cf @ 12.90 hrs
Average Depth at Peak Storage= 3.93'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 62.00 cfs

2.00' x 4.00' deep channel, n= 0.022
Side Slope Z-value= 2.5 '/' Top Width= 22.00'
Length= 3,535.0' Slope= 0.0001 '/'
Inlet Invert= 412.50', Outlet Invert= 412.00'



Reach C-4A: Channel 4A



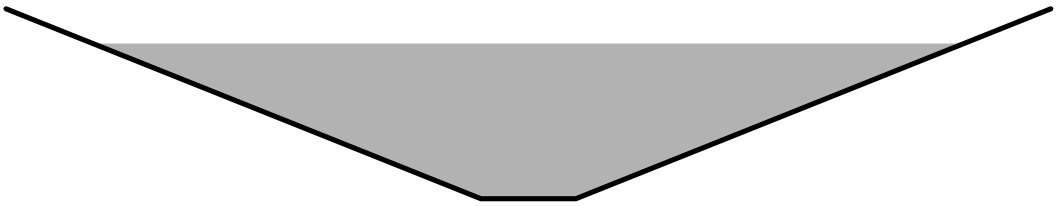
Summary for Reach C-4B: Channel 4B

Inflow Area = 27.240 ac, 0.00% Impervious, Inflow Depth = 3.77" for 25-YR event
Inflow = 97.40 cfs @ 12.19 hrs, Volume= 8.553 af
Outflow = 62.41 cfs @ 12.77 hrs, Volume= 8.553 af, Atten= 36%, Lag= 35.0 min

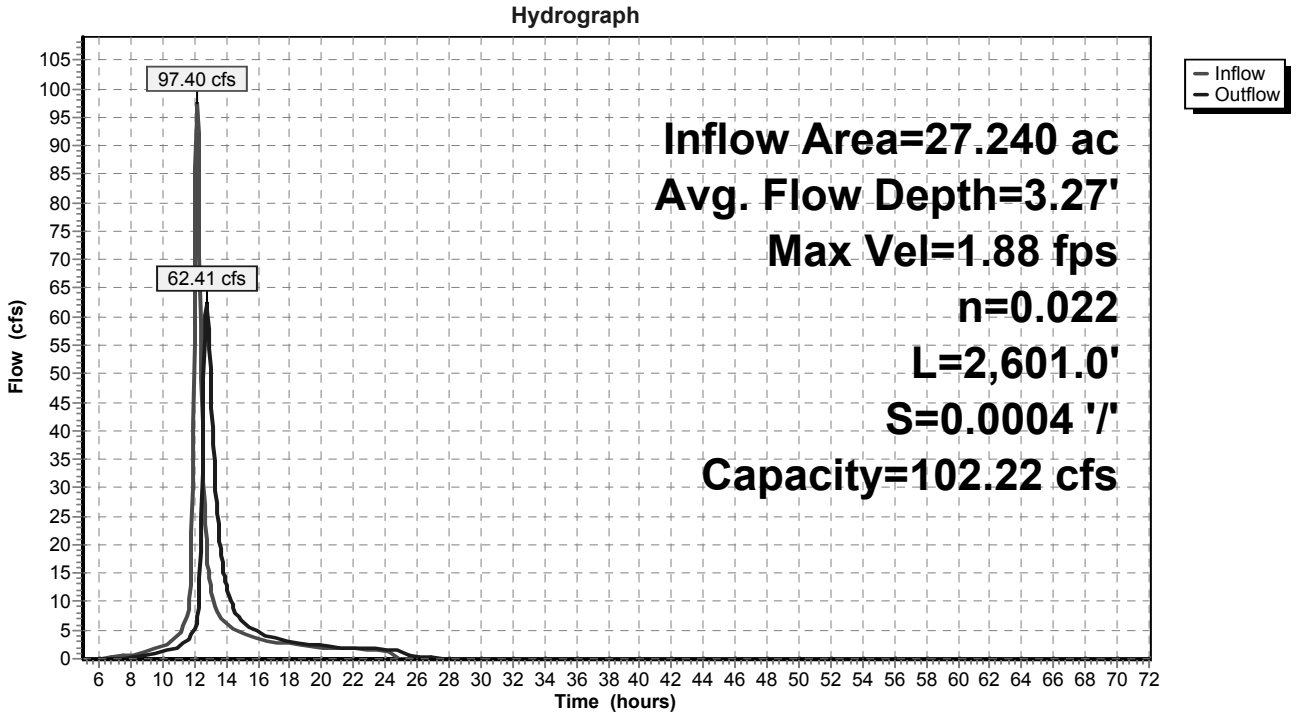
Routing by Stor-Ind+Trans method, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.88 fps, Min. Travel Time= 23.0 min
Avg. Velocity = 0.39 fps, Avg. Travel Time= 112.0 min

Peak Storage= 86,408 cf @ 12.39 hrs
Average Depth at Peak Storage= 3.27'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 102.22 cfs

2.00' x 4.00' deep channel, n= 0.022
Side Slope Z-value= 2.5 '/' Top Width= 22.00'
Length= 2,601.0' Slope= 0.0004 '/'
Inlet Invert= 413.00', Outlet Invert= 412.00'



Reach C-4B: Channel 4B

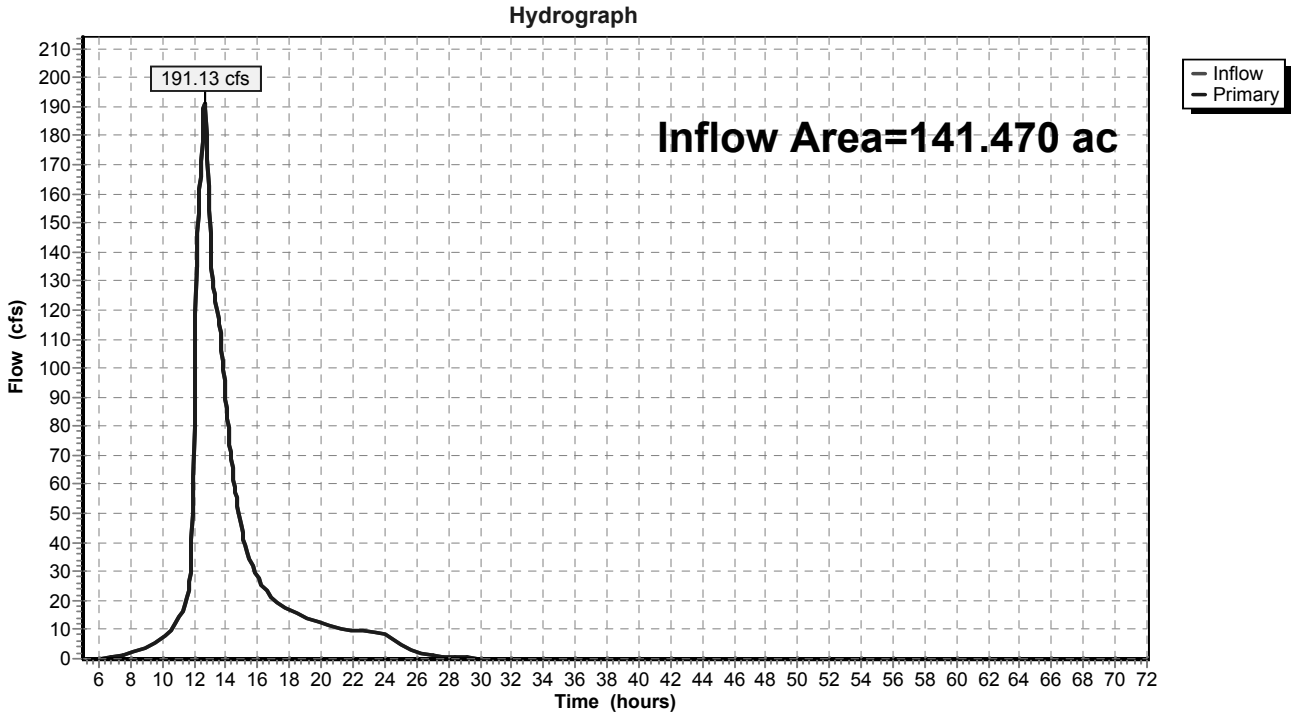


Summary for Link POI-2: POST-DEV POI-2

Inflow Area = 141.470 ac, 4.07% Impervious, Inflow Depth = 3.84" for 25-YR event
Inflow = 191.13 cfs @ 12.66 hrs, Volume= 45.245 af
Primary = 191.13 cfs @ 12.66 hrs, Volume= 45.245 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs

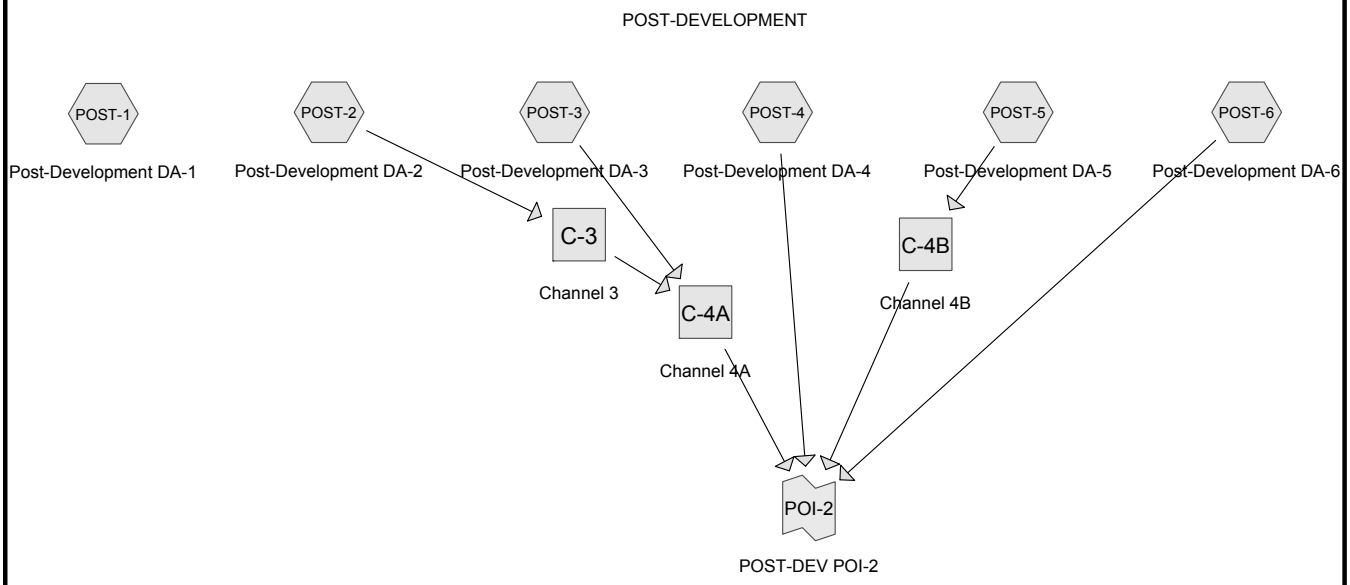
Link POI-2: POST-DEV POI-2



Appendix D

HydroCAD Output:

100-year/24-hour Storm Event



Subcat Reach Pond Link

Routing Diagram for HA100254_Peak_Rate
Prepared by {enter your company name here}, Printed 3/22/2016

Time span=5.00-72.00 hrs, dt=0.05 hrs, 1341 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment POST-1: Post-Development Runoff Area=30.580 ac 6.31% Impervious Runoff Depth>5.87"
Flow Length=1,730' Tc=43.0 min CN=85 Runoff=119.98 cfs 14.969 af
↑ CHANNEL 1 FLOW

Subcatchment POST-2: Post-Development Runoff Area=26.530 ac 2.26% Impervious Runoff Depth>5.76"
Flow Length=1,318' Tc=43.1 min CN=84 Runoff=102.40 cfs 12.732 af
↑ CHANNEL 2 FLOW

Subcatchment POST-3: Post-Development Runoff Area=14.550 ac 20.82% Impervious Runoff Depth>6.10"
Flow Length=1,826' Tc=46.6 min CN=87 Runoff=55.67 cfs 7.399 af

Subcatchment POST-4: Post-Development Runoff Area=52.510 ac 4.06% Impervious Runoff Depth>5.87"
Flow Length=4,184' Tc=57.0 min CN=85 Runoff=168.75 cfs 25.708 af

Subcatchment POST-5: Post-Development Runoff Area=27.240 ac 0.00% Impervious Runoff Depth>5.76"
Flow Length=1,604' Tc=25.7 min CN=84 Runoff=146.84 cfs 13.071 af
↑ CHANNEL 5 FLOW

Subcatchment POST-6: Post-Development Runoff Area=20.640 ac 0.00% Impervious Runoff Depth>5.76"
Flow Length=1,631' Tc=24.7 min CN=84 Runoff=113.99 cfs 9.904 af
↑ CHANNEL 6 FLOW

Reach C-3: Channel 3 Avg. Flow Depth=2.28' Max Vel=2.26 fps Inflow=102.40 cfs 12.732 af
n=0.022 L=571.0' S=0.0005 '/' Capacity=165.84 cfs Outflow=100.47 cfs 12.732 af

Reach C-4A: Channel 4A Avg. Flow Depth=4.85' Max Vel=1.41 fps → Inflow=154.89 cfs 20.132 af
n=0.022 L=3,535.0' S=0.0001 '/' Capacity=62.00 cfs Outflow=93.91 cfs 20.131 af
↑ CHANNEL 3 FLOW

Reach C-4B: Channel 4B Avg. Flow Depth=3.96' Max Vel=2.11 fps Inflow=146.84 cfs 13.071 af
n=0.022 L=2,601.0' S=0.0004 '/' Capacity=102.22 cfs Outflow=99.43 cfs 13.071 af

Link POI-2: POST-DEV POI-2 Inflow=303.25 cfs 68.813 af
Primary=303.25 cfs 68.813 af
↑ CHANNEL 4 FLOW

Total Runoff Area = 172.050 ac Runoff Volume = 83.784 af Average Runoff Depth = 5.84"
95.53% Pervious = 164.360 ac 4.47% Impervious = 7.690 ac

Summary for Subcatchment POST-1: Post-Development DA-1

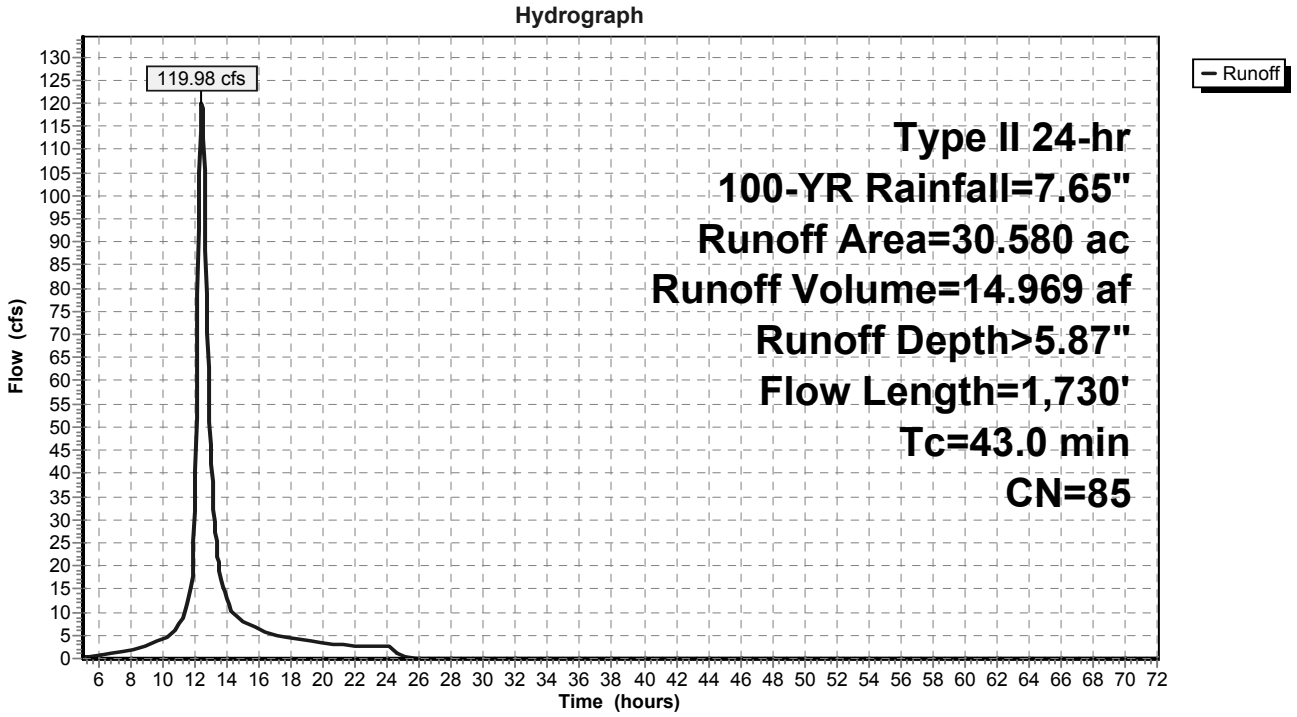
Runoff = 119.98 cfs @ 12.39 hrs, Volume= 14.969 af, Depth> 5.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR Rainfall=7.65"

Area (ac)	CN	Description
1.930	98	Paved parking, HSG D
28.650	84	50-75% Grass cover, Fair, HSG D
30.580	85	Weighted Average
28.650		93.69% Pervious Area
1.930		6.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.3	100	0.0080	0.07		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 1.00"
8.2	707	0.0080	1.44		**Shallow Concentrated Flow, Shallow Concentrated Flow** Unpaved Kv= 16.1 fps
0.0	16	0.5000	10.61		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
0.7	230	0.0020	5.14	323.57	**Trap/Vee/Rect Channel Flow, Channelized Flow** Bot.W=15.00' D=3.00' Z= 2.0 '/' Top.W=27.00' n= 0.022 Earth, clean & straight
0.9	54	0.0001	0.99	4.85	**Pipe Channel, 30" RCP Pipe Flow** 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011 Concrete pipe, straight & clean
5.9	232	0.0001	0.65	8.51	**Trap/Vee/Rect Channel Flow, Channelized Flow** Bot.W=0.00' D=2.00' Z= 2.5 & 4.0 '/' Top.W=13.00' n= 0.022 Earth, clean & straight
0.1	19	0.0260	4.98	8.81	**Pipe Channel, 18" CMP Pipe Flow** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.025 Corrugated metal
1.9	372	0.0200	3.34	2.62	**Pipe Channel, 12" CMP Pipe Flow** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.025 Corrugated metal
43.0	1,730	Total			

Subcatchment POST-1: Post-Development DA-1



Summary for Subcatchment POST-2: Post-Development DA-2

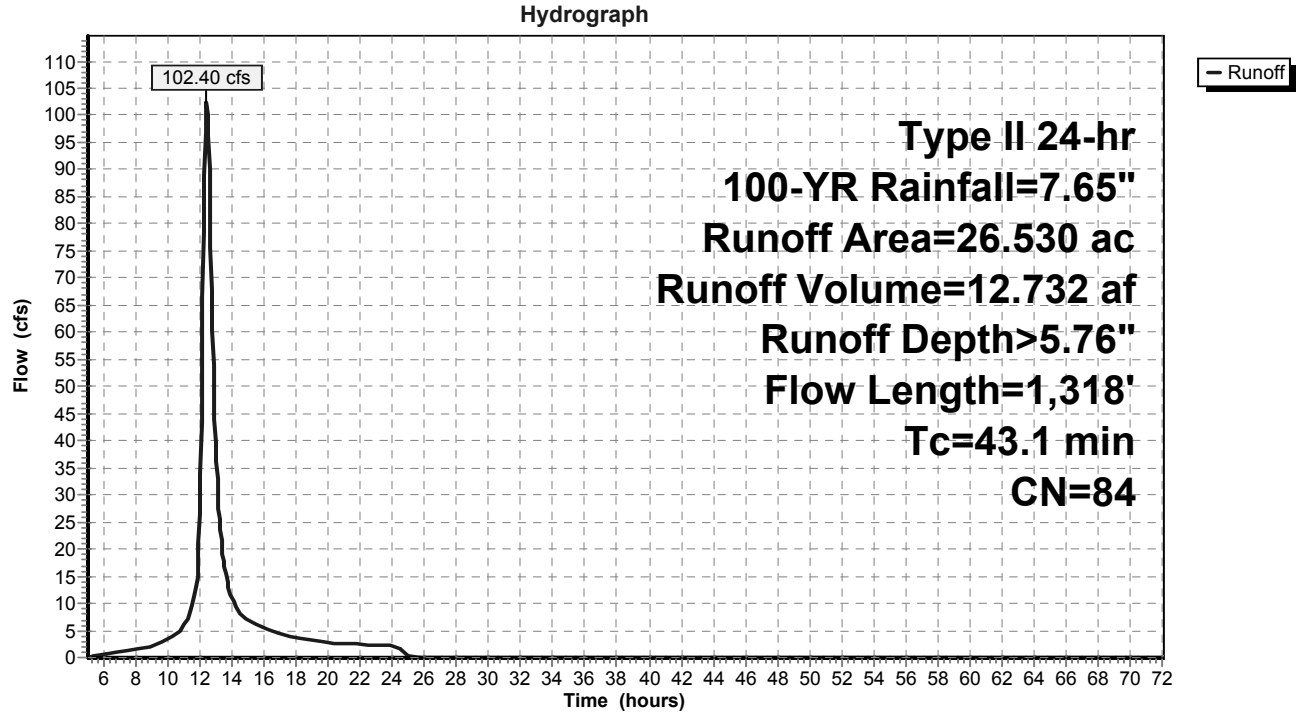
Runoff = 102.40 cfs @ 12.39 hrs, Volume= 12.732 af, Depth> 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR Rainfall=7.65"

Area (ac)	CN	Description
0.600	98	Paved parking, HSG D
25.930	84	50-75% Grass cover, Fair, HSG D
26.530	84	Weighted Average
25.930		97.74% Pervious Area
0.600		2.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.7	100	0.0070	0.06		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 1.00"
16.2	1,130	0.0060	1.16		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
0.0	15	0.3330	8.66		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
0.2	73	0.0020	5.14	323.57	**Trap/Vee/Rect Channel Flow, Channelized Flow** Bot.W=15.00' D=3.00' Z= 2.0 '/' Top.W=27.00' n= 0.022 Earth, clean & straight
43.1	1,318	Total			

Subcatchment POST-2: Post-Development DA-2



Summary for Subcatchment POST-3: Post-Development DA-3

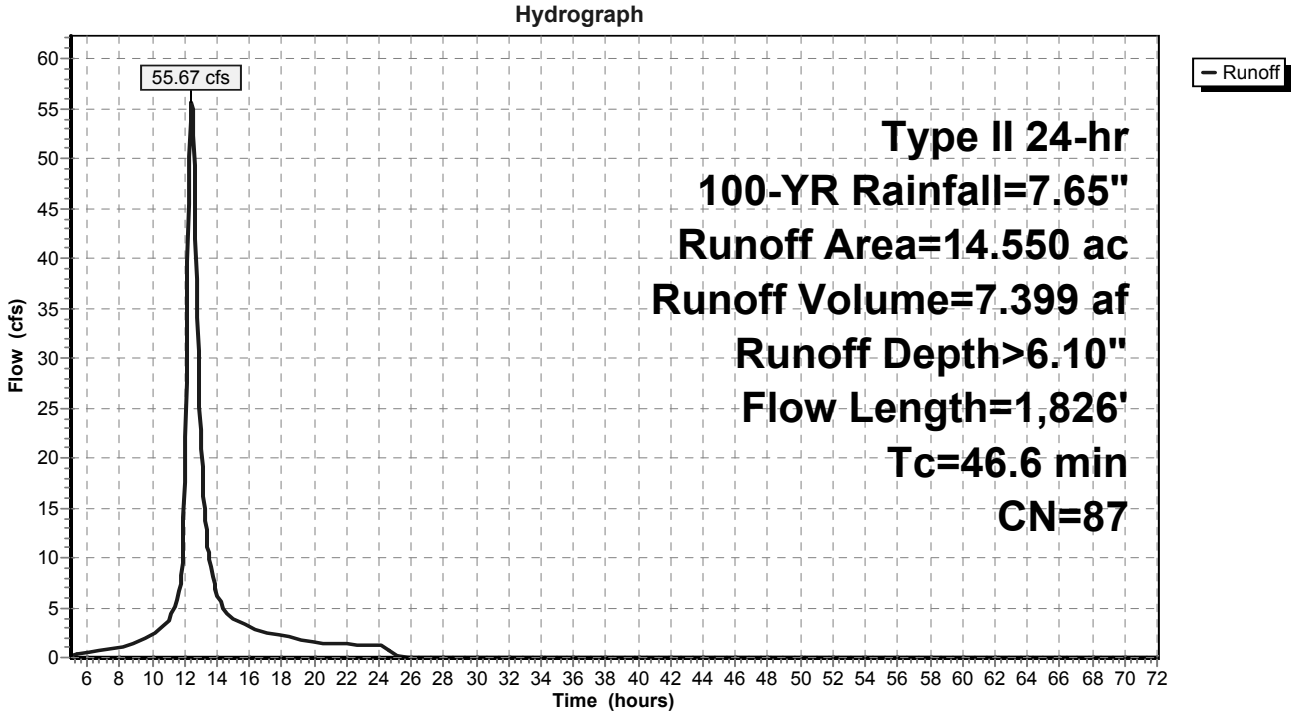
Runoff = 55.67 cfs @ 12.43 hrs, Volume= 7.399 af, Depth> 6.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR Rainfall=7.65"

Area (ac)	CN	Description
3.030	98	Paved parking, HSG D
11.520	84	50-75% Grass cover, Fair, HSG D
14.550	87	Weighted Average
11.520		79.18% Pervious Area
3.030		20.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.4	100	0.0060	0.06		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 1.00"
16.3	1,139	0.0060	1.16		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
0.0	16	0.3330	8.66		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
1.9	571	0.0020	5.14	323.57	**Trap/Vee/Rect Channel Flow, Channelized Flow** Bot.W=15.00' D=3.00' Z= 2.0 '/' Top.W=27.00' n= 0.022 Earth, clean & straight
46.6	1,826	Total			

Subcatchment POST-3: Post-Development DA-3



Summary for Subcatchment POST-4: Post-Development DA-4

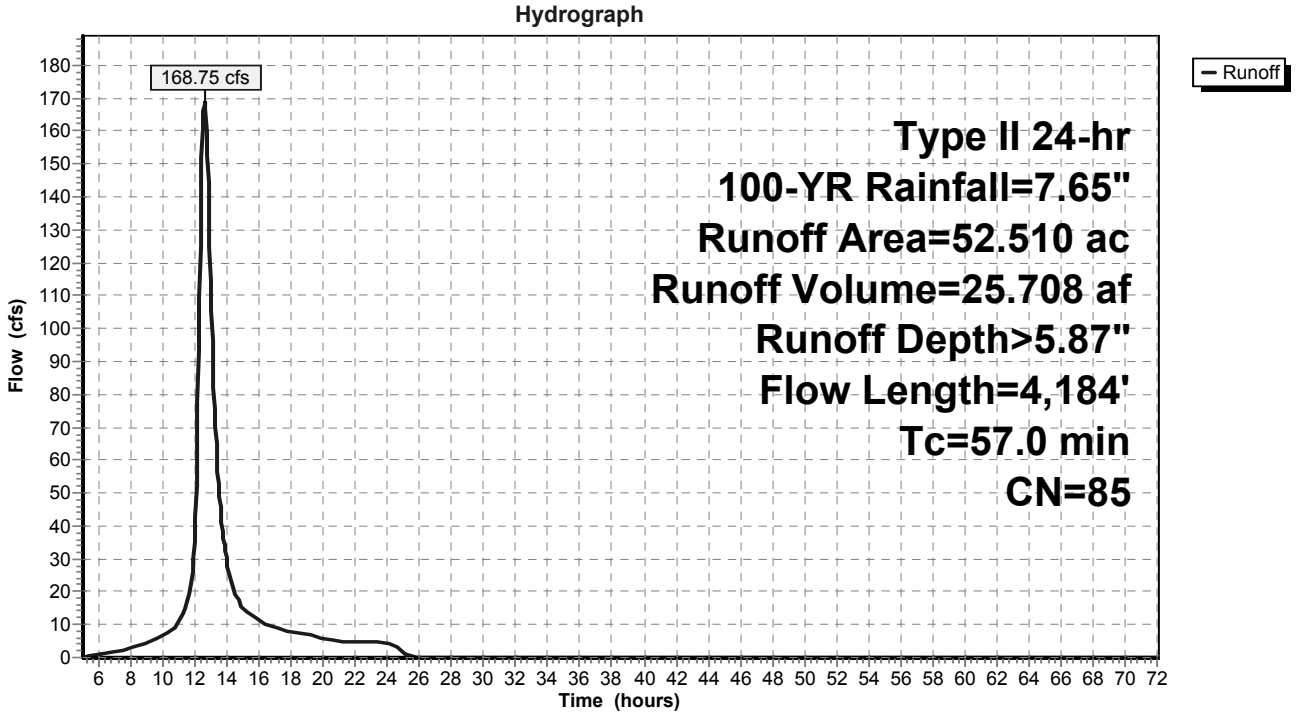
Runoff = 168.75 cfs @ 12.57 hrs, Volume= 25.708 af, Depth> 5.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR Rainfall=7.65"

Area (ac)	CN	Description
2.130	98	Paved parking, HSG D
50.380	84	50-75% Grass cover, Fair, HSG D
52.510	85	Weighted Average
50.380		95.94% Pervious Area
2.130		4.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.4	100	0.0060	0.06		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 1.00"
13.4	931	0.0060	1.16		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
0.0	15	0.3330	8.66		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
15.2	3,138	0.0010	3.43	164.86	**Trap/Vee/Rect Channel Flow, Channelized Flow** Bot.W=2.00' D=4.00' Z= 2.5 '/' Top.W=22.00' n= 0.022 Earth, clean & straight
57.0	4,184	Total			

Subcatchment POST-4: Post-Development DA-4



Summary for Subcatchment POST-5: Post-Development DA-5

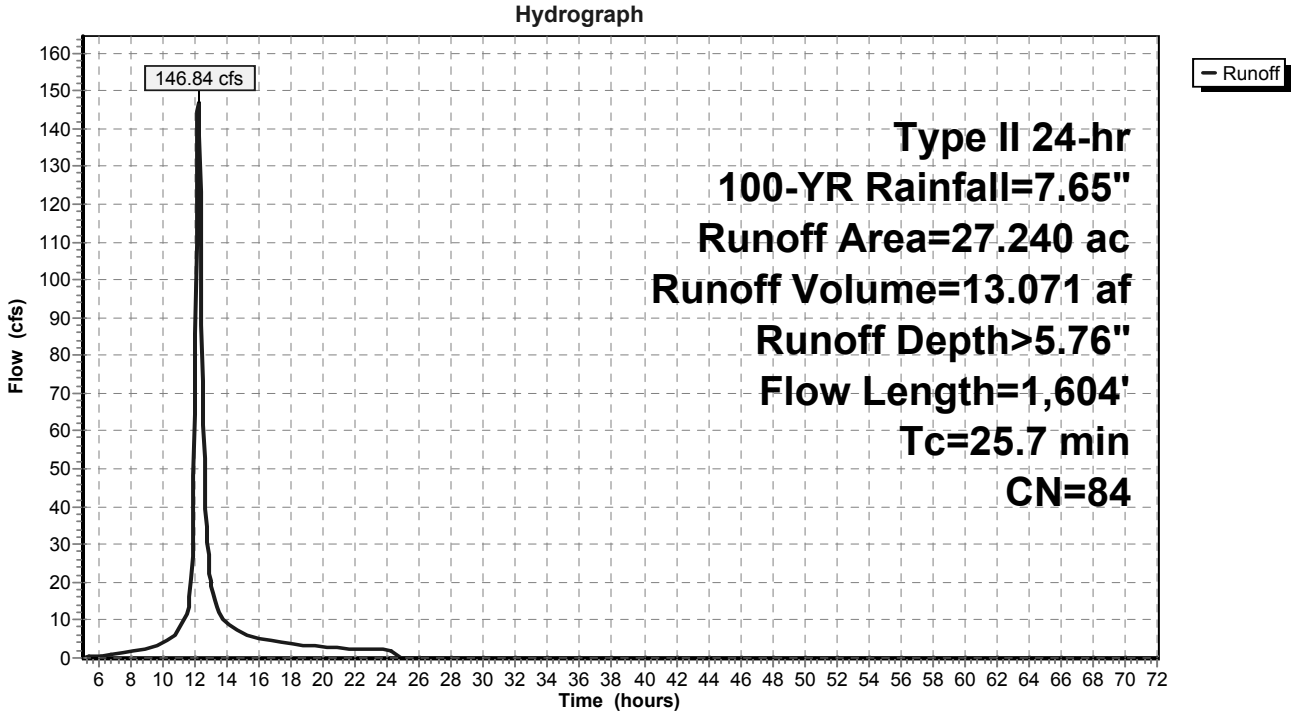
Runoff = 146.84 cfs @ 12.18 hrs, Volume= 13.071 af, Depth> 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR Rainfall=7.65"

Area (ac)	CN	Description
27.240	84	50-75% Grass cover, Fair, HSG D
27.240		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.2	100	0.0160	0.09		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 1.00"
2.6	301	0.0170	1.96		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
0.0	15	0.3330	8.66		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
3.9	1,188	0.0020	5.14	323.57	**Trap/Vee/Rect Channel Flow, Channelized Flow** Bot.W=15.00' D=3.00' Z= 2.0 '/' Top.W=27.00' n= 0.022 Earth, clean & straight
25.7	1,604	Total			

Subcatchment POST-5: Post-Development DA-5



Summary for Subcatchment POST-6: Post-Development DA-6

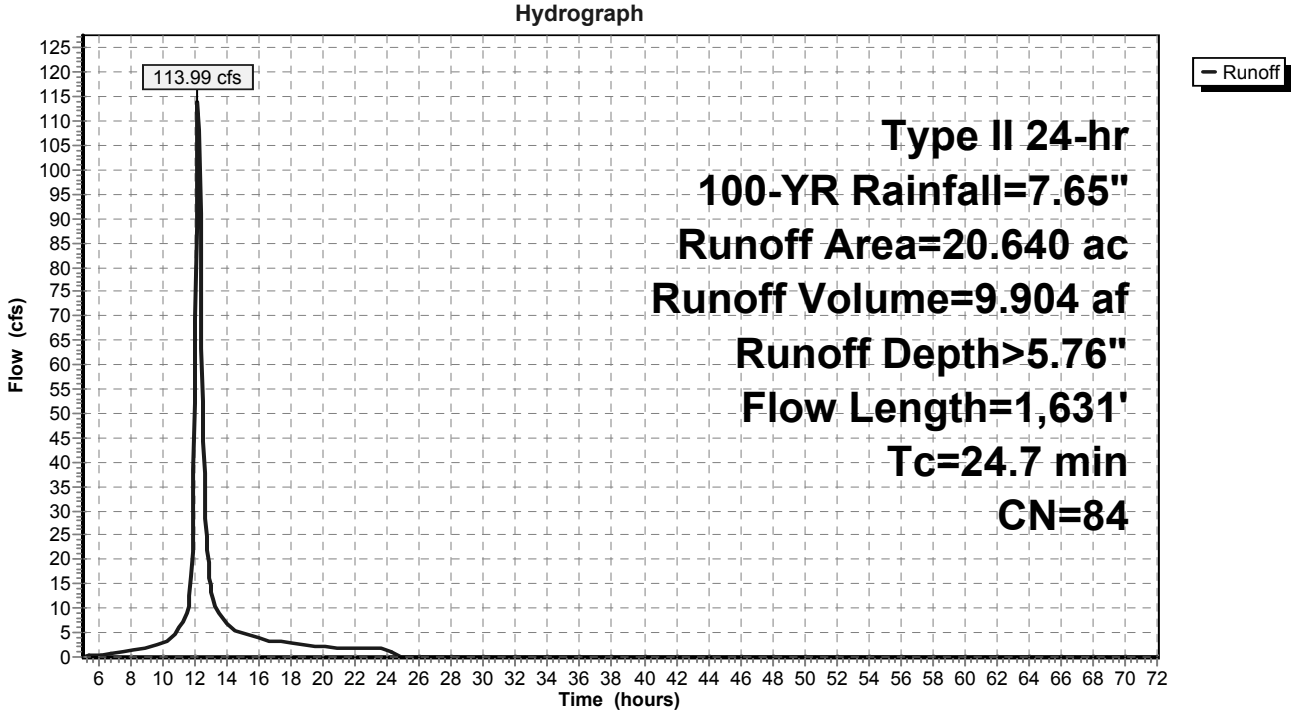
Runoff = 113.99 cfs @ 12.17 hrs, Volume= 9.904 af, Depth> 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR Rainfall=7.65"

Area (ac)	CN	Description
20.640	84	50-75% Grass cover, Fair, HSG D
20.640		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	100	0.0260	0.11		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 1.00"
2.9	465	0.0320	2.68		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
3.6	310	0.0090	1.42		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
0.0	13	0.3330	8.66		**Shallow Concentrated Flow, Shallow Concentrated Flow** Grassed Waterway Kv= 15.0 fps
2.4	743	0.0020	5.14	323.57	**Trap/Vee/Rect Channel Flow, Channelized Flow** Bot.W=15.00' D=3.00' Z= 2.0 '/' Top.W=27.00' n= 0.022 Earth, clean & straight
24.7	1,631	Total			

Subcatchment POST-6: Post-Development DA-6



Summary for Reach C-3: Channel 3

Inflow Area = 26.530 ac, 2.26% Impervious, Inflow Depth > 5.76" for 100-YR event
Inflow = 102.40 cfs @ 12.39 hrs, Volume= 12.732 af
Outflow = 100.47 cfs @ 12.52 hrs, Volume= 12.732 af, Atten= 2%, Lag= 7.4 min

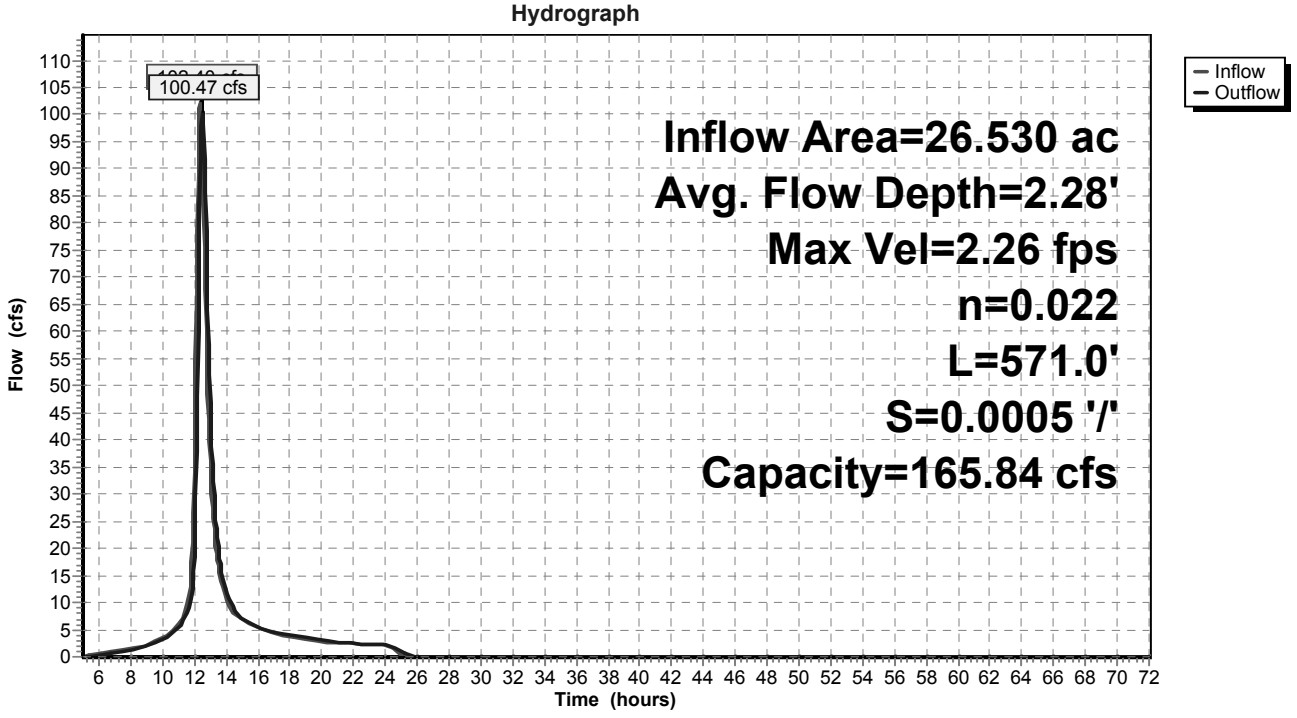
Routing by Stor-Ind+Trans method, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.26 fps, Min. Travel Time= 4.2 min
Avg. Velocity = 0.55 fps, Avg. Travel Time= 17.3 min

Peak Storage= 25,423 cf @ 12.44 hrs
Average Depth at Peak Storage= 2.28'
Bank-Full Depth= 3.00' Flow Area= 63.0 sf, Capacity= 165.84 cfs

15.00' x 3.00' deep channel, n= 0.022
Side Slope Z-value= 2.0 '/' Top Width= 27.00'
Length= 571.0' Slope= 0.0005 '/'
Inlet Invert= 415.40', Outlet Invert= 415.10'

‡

Reach C-3: Channel 3



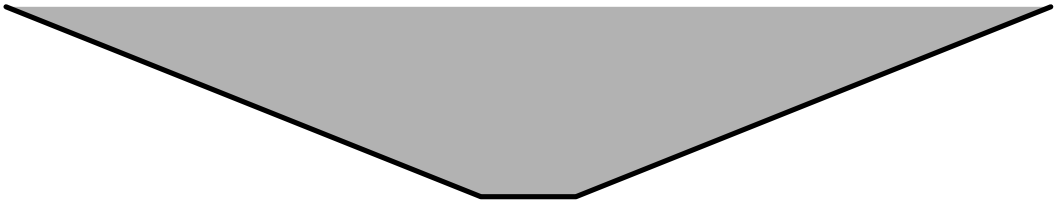
Summary for Reach C-4A: Channel 4A

Inflow Area = 41.080 ac, 8.84% Impervious, Inflow Depth > 5.88" for 100-YR event
Inflow = 154.89 cfs @ 12.49 hrs, Volume= 20.132 af
Outflow = 93.91 cfs @ 13.55 hrs, Volume= 20.131 af, Atten= 39%, Lag= 63.7 min

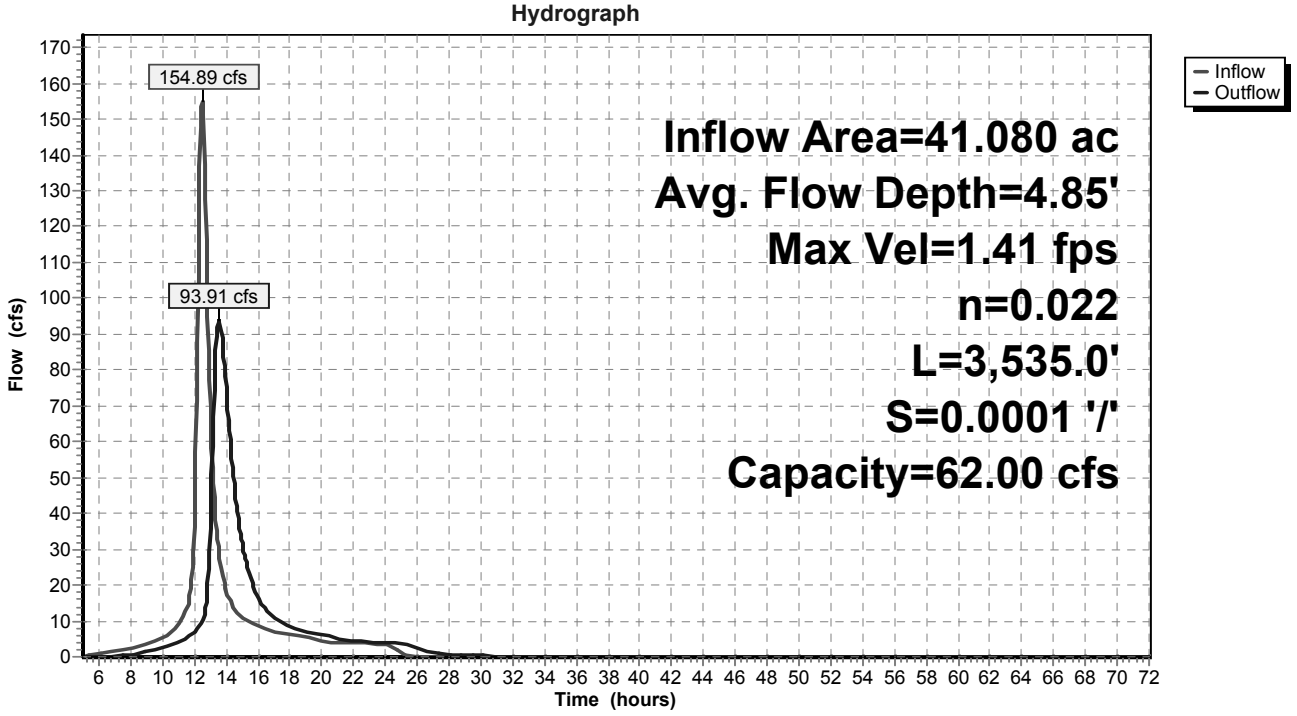
Routing by Stor-Ind+Trans method, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.41 fps, Min. Travel Time= 41.8 min
Avg. Velocity = 0.31 fps, Avg. Travel Time= 188.8 min

Peak Storage= 235,410 cf @ 12.86 hrs
Average Depth at Peak Storage= 4.85'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 62.00 cfs

2.00' x 4.00' deep channel, n= 0.022
Side Slope Z-value= 2.5 '/' Top Width= 22.00'
Length= 3,535.0' Slope= 0.0001 '/'
Inlet Invert= 412.50', Outlet Invert= 412.00'



Reach C-4A: Channel 4A



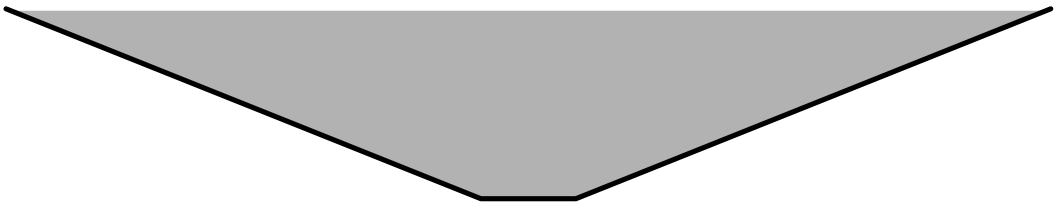
Summary for Reach C-4B: Channel 4B

Inflow Area = 27.240 ac, 0.00% Impervious, Inflow Depth > 5.76" for 100-YR event
Inflow = 146.84 cfs @ 12.18 hrs, Volume= 13.071 af
Outflow = 99.43 cfs @ 12.71 hrs, Volume= 13.071 af, Atten= 32%, Lag= 31.6 min

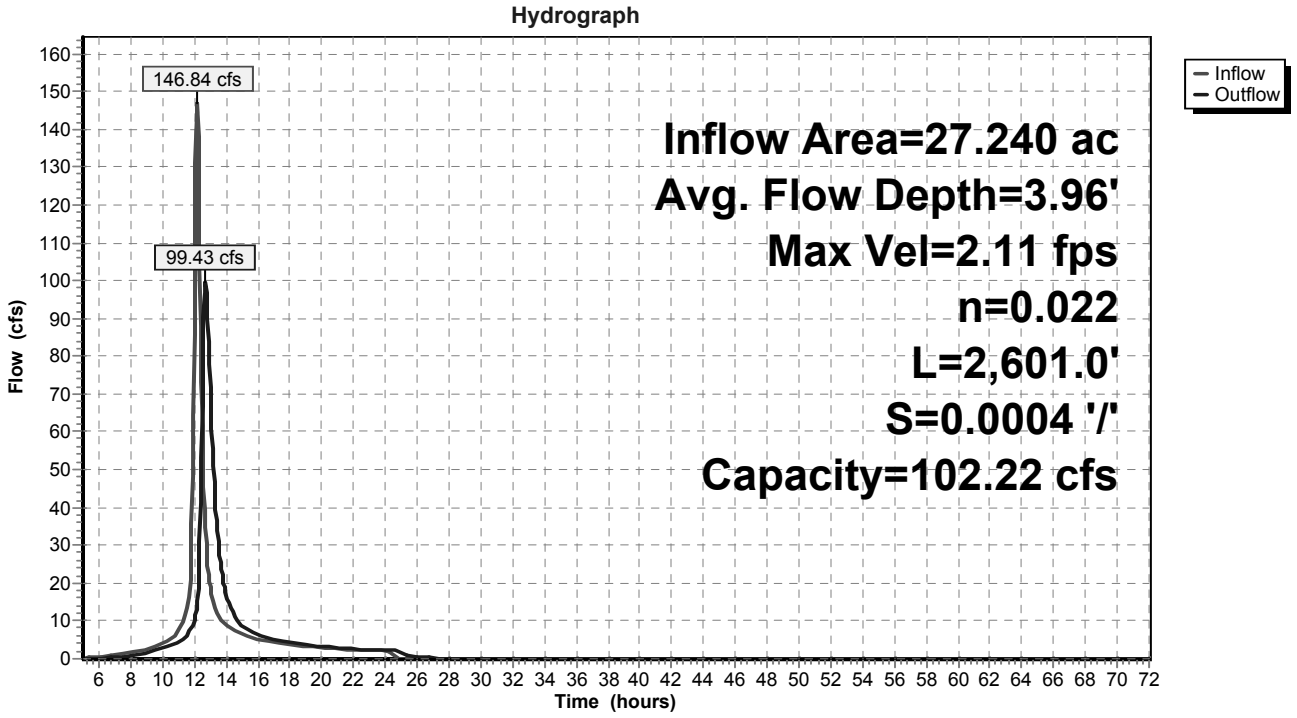
Routing by Stor-Ind+Trans method, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.11 fps, Min. Travel Time= 20.5 min
Avg. Velocity = 0.43 fps, Avg. Travel Time= 101.4 min

Peak Storage= 122,506 cf @ 12.37 hrs
Average Depth at Peak Storage= 3.96'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 102.22 cfs

2.00' x 4.00' deep channel, n= 0.022
Side Slope Z-value= 2.5 '/' Top Width= 22.00'
Length= 2,601.0' Slope= 0.0004 '/'
Inlet Invert= 413.00', Outlet Invert= 412.00'



Reach C-4B: Channel 4B

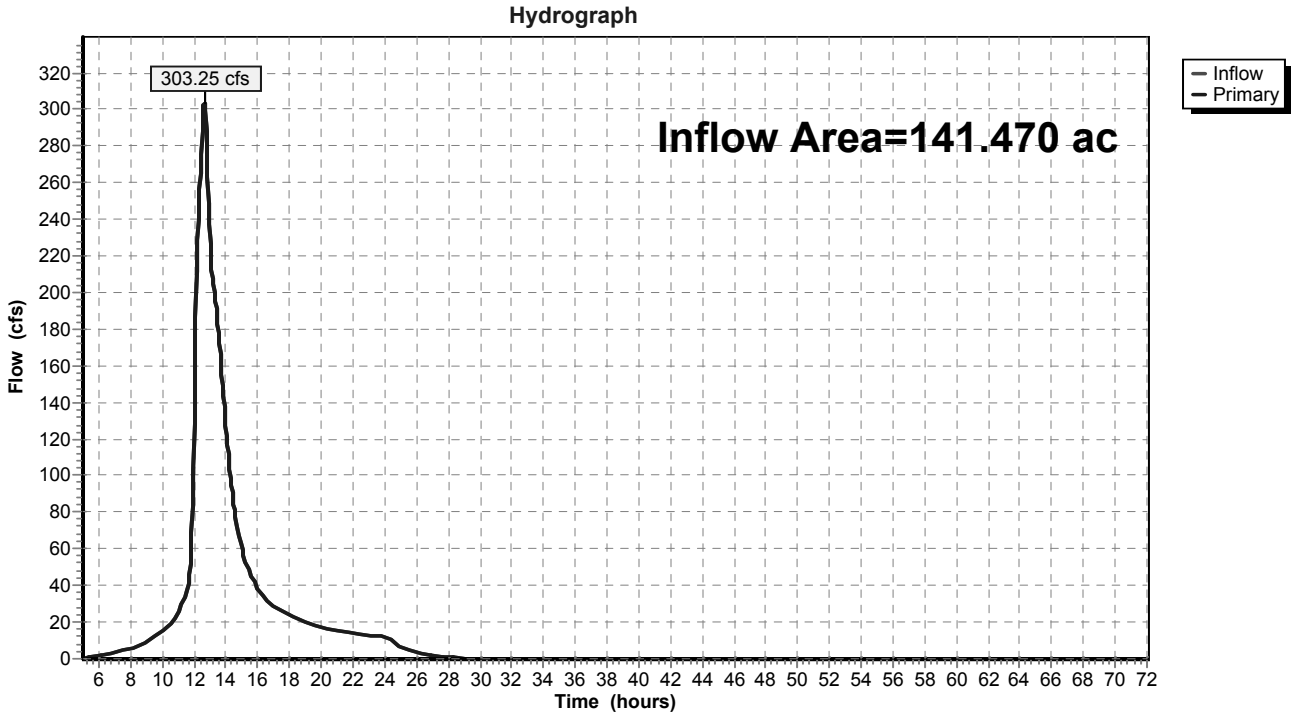


Summary for Link POI-2: POST-DEV POI-2

Inflow Area = 141.470 ac, 4.07% Impervious, Inflow Depth > 5.84" for 100-YR event
Inflow = 303.25 cfs @ 12.62 hrs, Volume= 68.813 af
Primary = 303.25 cfs @ 12.62 hrs, Volume= 68.813 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-72.00 hrs, dt= 0.05 hrs

Link POI-2: POST-DEV POI-2



Appendix E

AutoDesk Hydraflow Express Output:

25-year/24-hour Storm Event

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Mar 22 2016

Channel 1 (25-Yr)

Trapezoidal

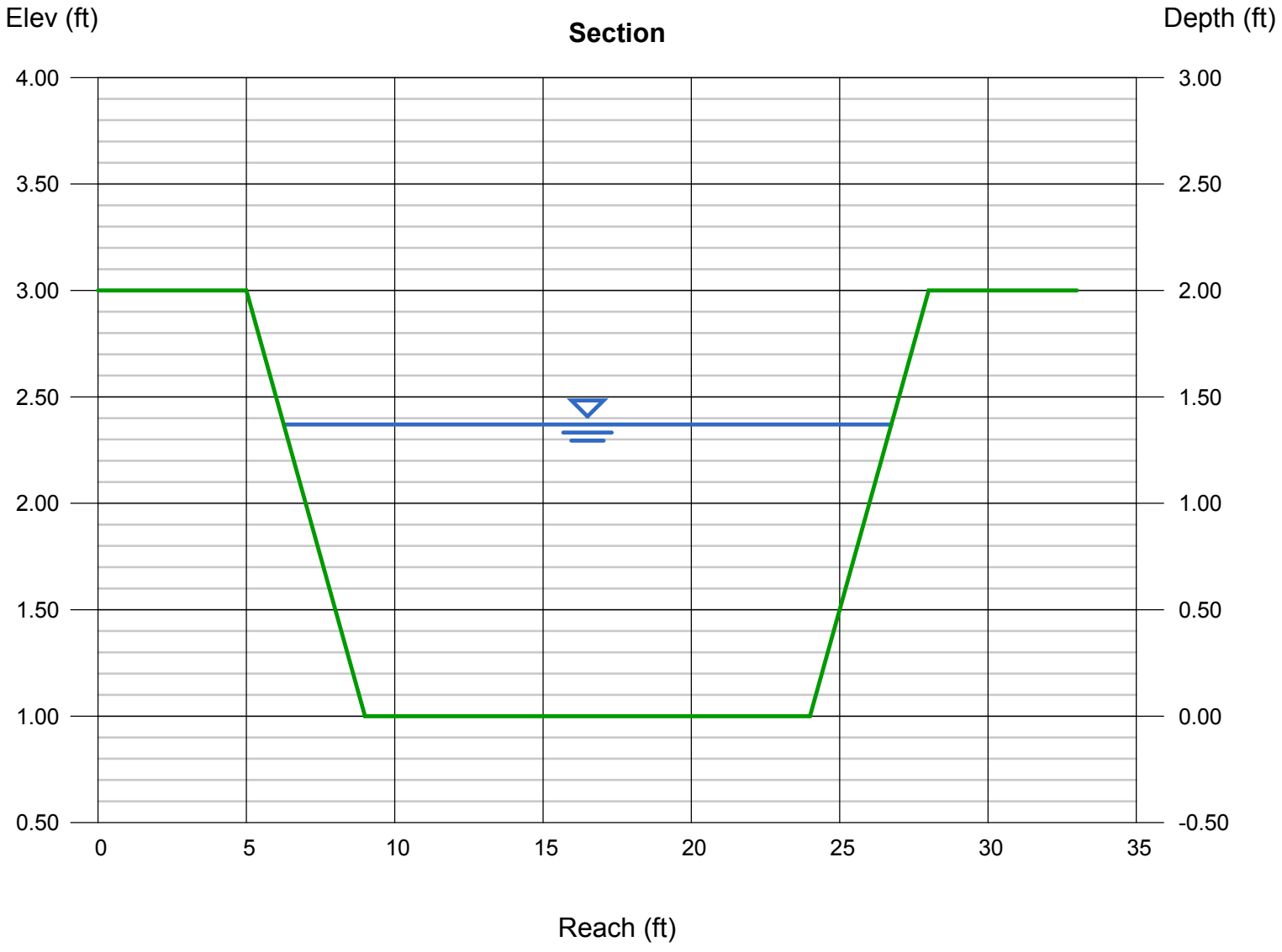
Bottom Width (ft)	= 15.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.20
N-Value	= 0.022

Calculations

Compute by:	Known Q
Known Q (cfs)	= 79.96

Highlighted

Depth (ft)	= 1.37
Q (cfs)	= 79.96
Area (sqft)	= 24.30
Velocity (ft/s)	= 3.29
Wetted Perim (ft)	= 21.13
Crit Depth, Yc (ft)	= 0.92
Top Width (ft)	= 20.48
EGL (ft)	= 1.54



Channel Report

Channel 2 (25-Yr)

Trapezoidal

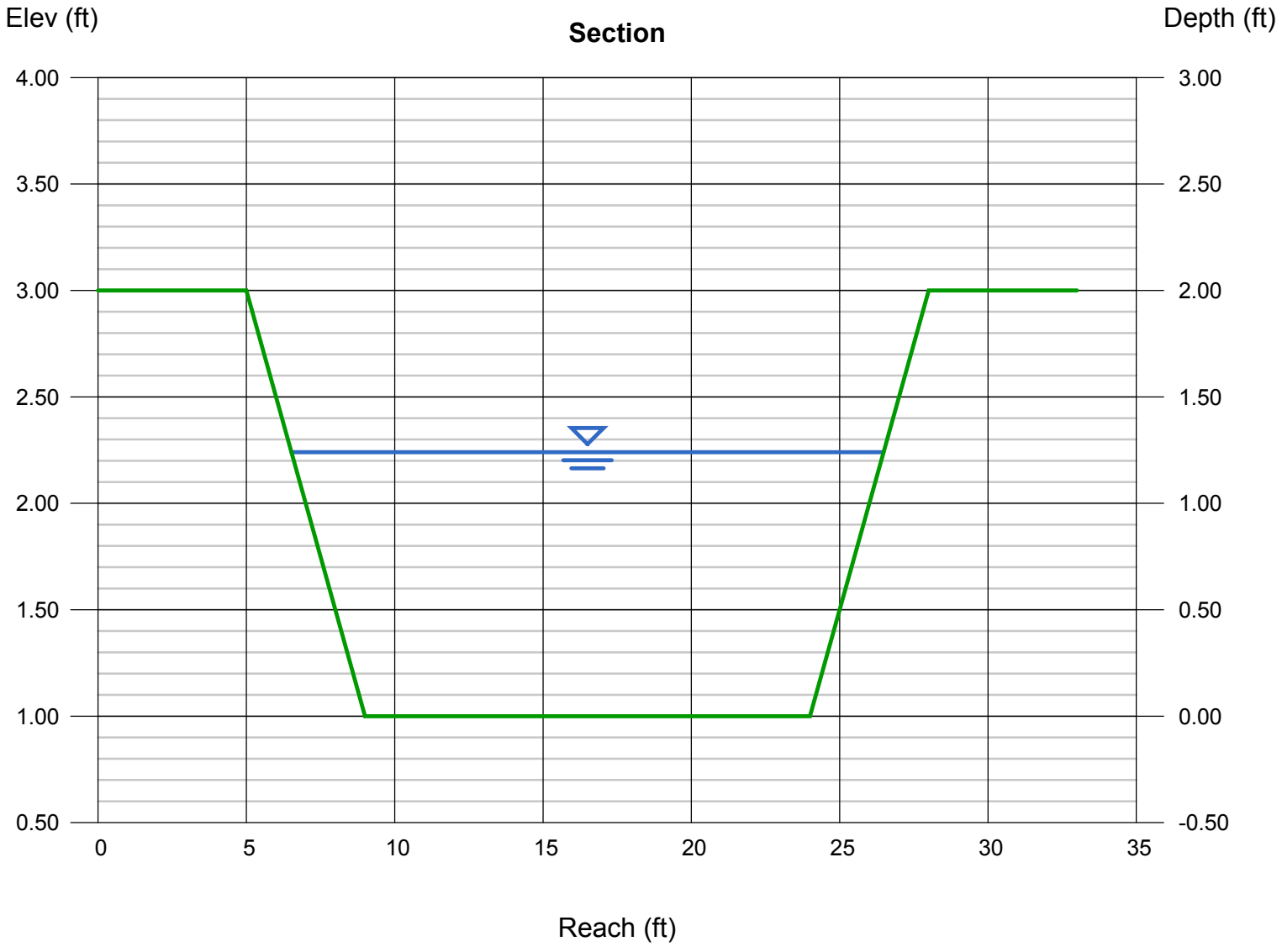
Bottom Width (ft)	= 15.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.20
N-Value	= 0.022

Calculations

Compute by:	Known Q
Known Q (cfs)	= 67.69

Highlighted

Depth (ft)	= 1.24
Q (cfs)	= 67.69
Area (sqft)	= 21.68
Velocity (ft/s)	= 3.12
Wetted Perim (ft)	= 20.55
Crit Depth, Yc (ft)	= 0.83
Top Width (ft)	= 19.96
EGL (ft)	= 1.39



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Mar 22 2016

Channel 3 (25-Yr)

Trapezoidal

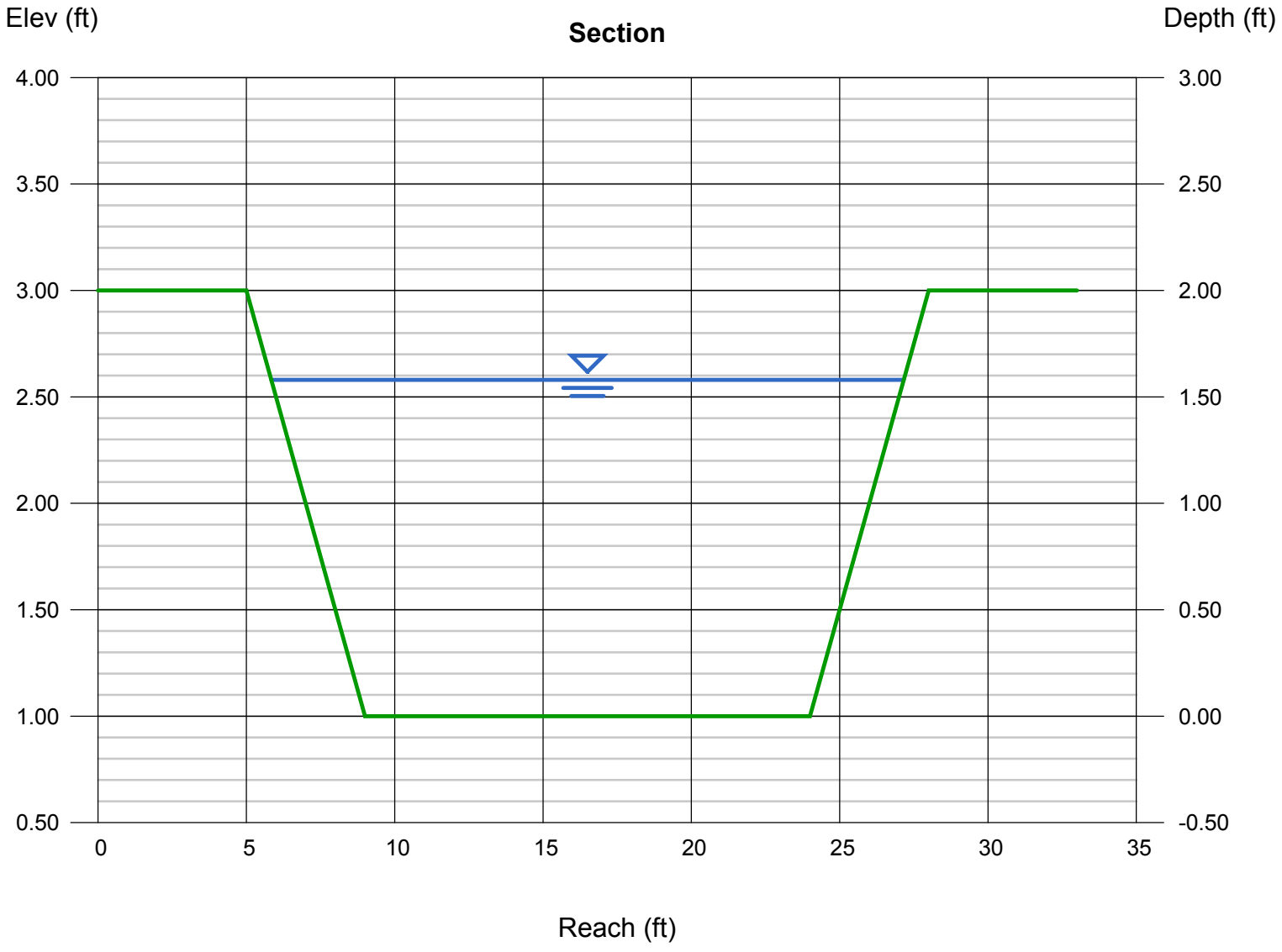
Bottom Width (ft)	= 15.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.20
N-Value	= 0.022

Calculations

Compute by:	Known Q
Known Q (cfs)	= 102.64

Highlighted

Depth (ft)	= 1.58
Q (cfs)	= 102.64
Area (sqft)	= 28.69
Velocity (ft/s)	= 3.58
Wetted Perim (ft)	= 22.07
Crit Depth, Yc (ft)	= 1.08
Top Width (ft)	= 21.32
EGL (ft)	= 1.78



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Mar 22 2016

Channel 4 (25-Yr)

Trapezoidal

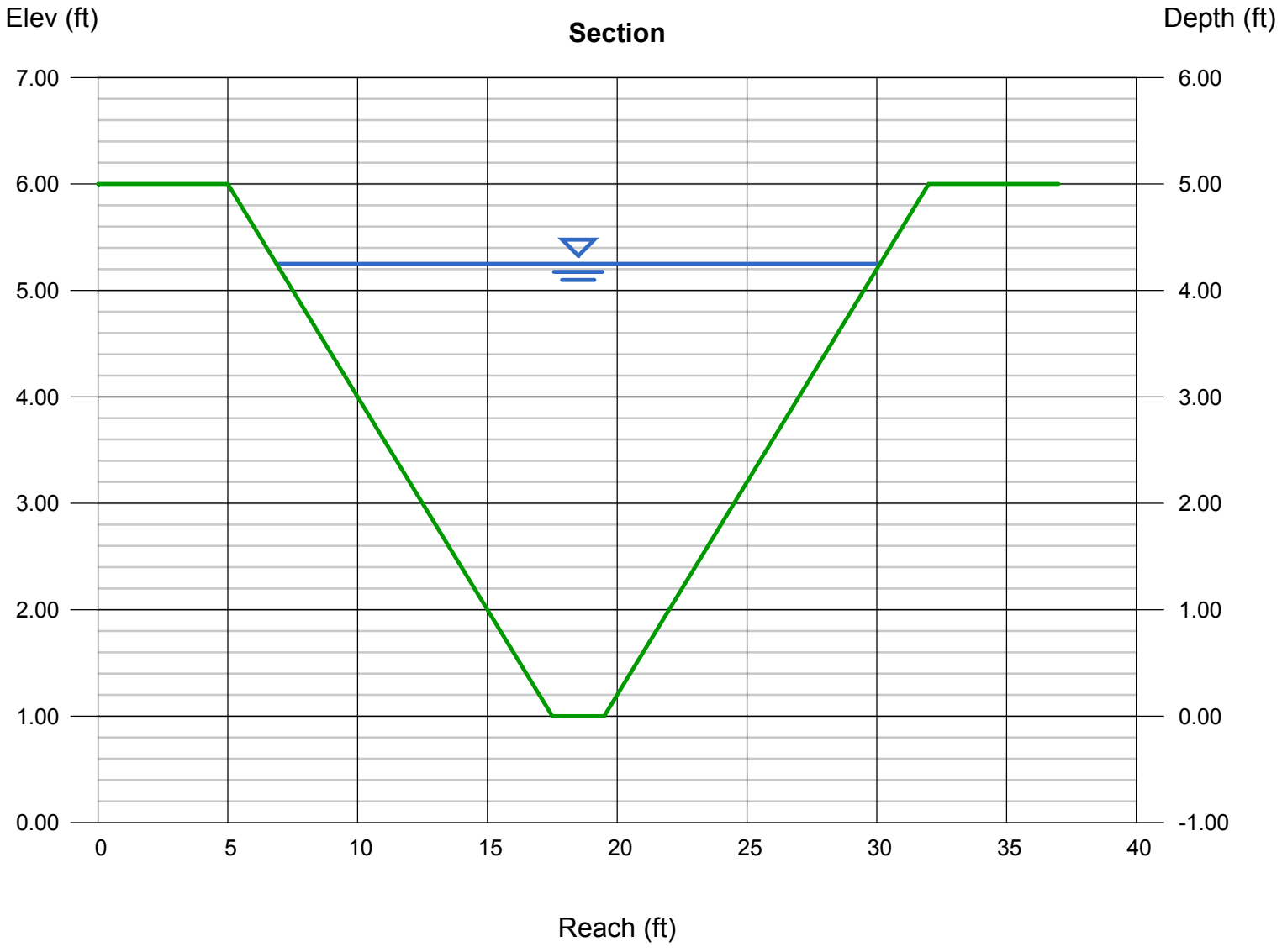
Bottom Width (ft)	= 2.00
Side Slopes (z:1)	= 2.50, 2.50
Total Depth (ft)	= 5.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.10
N-Value	= 0.022

Calculations

Compute by:	Known Q
Known Q (cfs)	= 191.13

Highlighted

Depth (ft)	= 4.25
Q (cfs)	= 191.13
Area (sqft)	= 53.66
Velocity (ft/s)	= 3.56
Wetted Perim (ft)	= 24.89
Crit Depth, Yc (ft)	= 2.89
Top Width (ft)	= 23.25
EGL (ft)	= 4.45



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Mar 22 2016

Channel 5 (25-Yr)

Trapezoidal

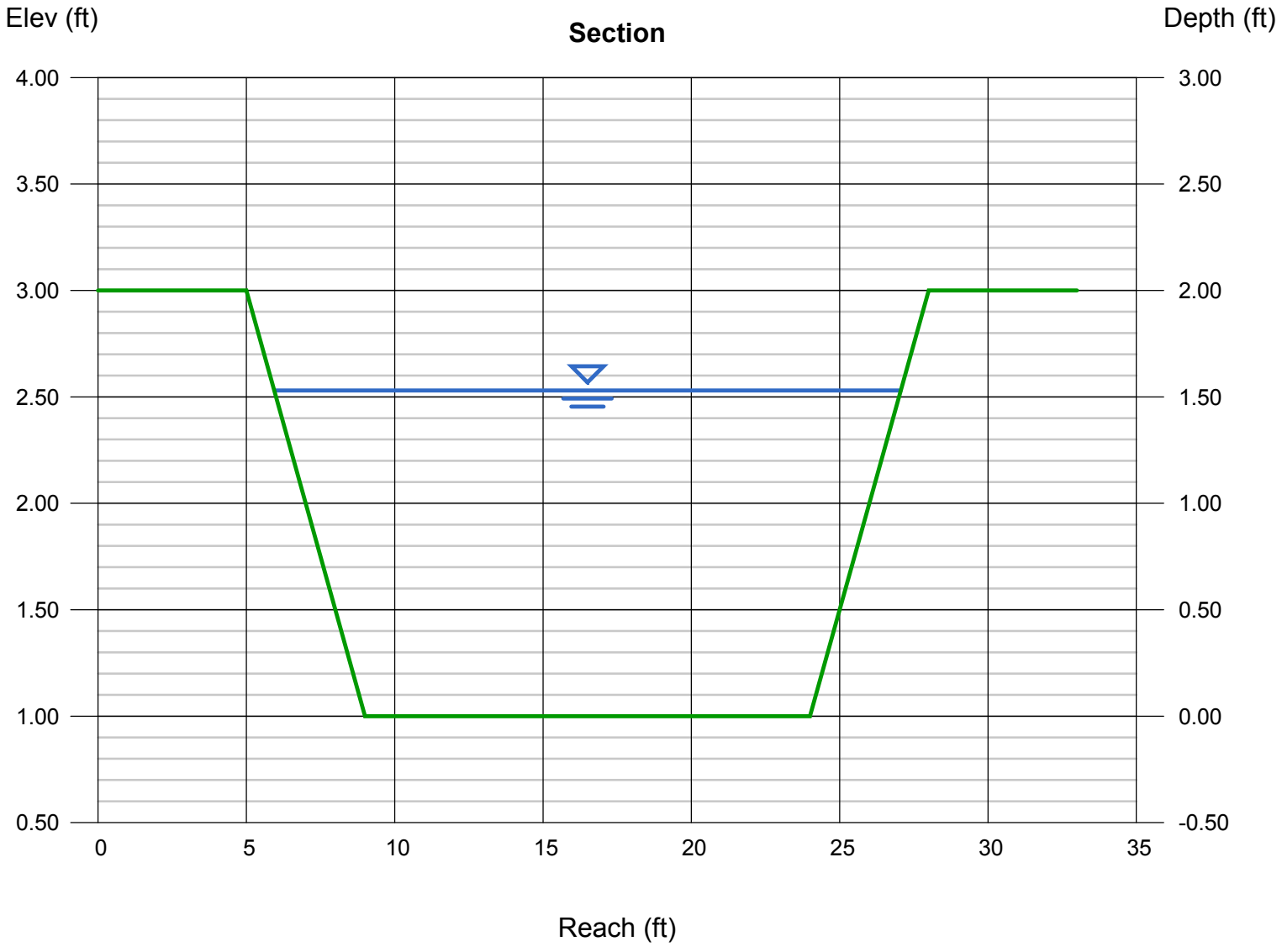
Bottom Width (ft)	= 15.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.20
N-Value	= 0.022

Calculations

Compute by:	Known Q
Known Q (cfs)	= 97.40

Highlighted

Depth (ft)	= 1.53
Q (cfs)	= 97.40
Area (sqft)	= 27.63
Velocity (ft/s)	= 3.52
Wetted Perim (ft)	= 21.84
Crit Depth, Yc (ft)	= 1.05
Top Width (ft)	= 21.12
EGL (ft)	= 1.72



Channel Report

Channel 6 (25-Yr)

Trapezoidal

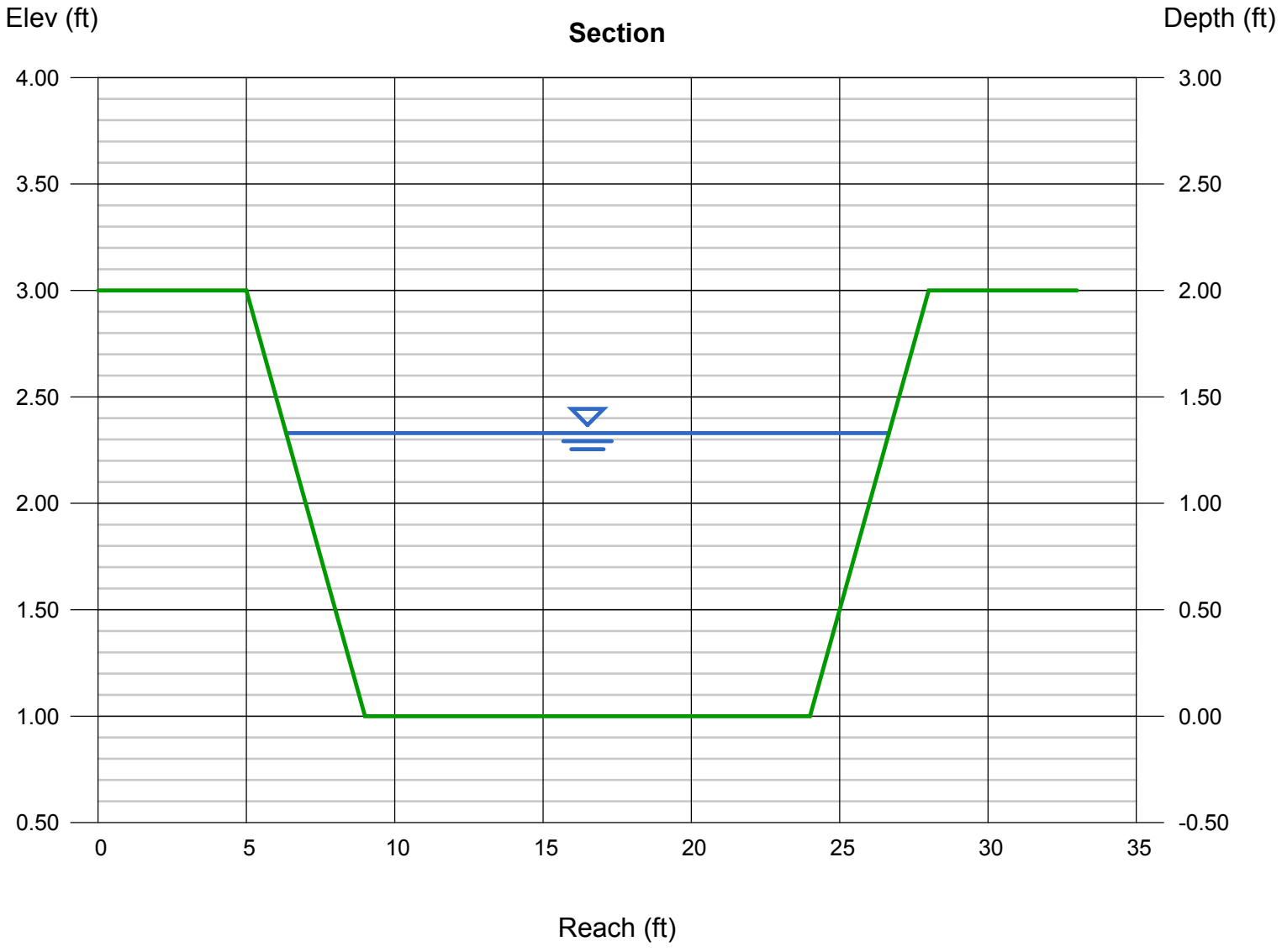
Bottom Width (ft)	= 15.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.20
N-Value	= 0.022

Calculations

Compute by:	Known Q
Known Q (cfs)	= 75.62

Highlighted

Depth (ft)	= 1.33
Q (cfs)	= 75.62
Area (sqft)	= 23.49
Velocity (ft/s)	= 3.22
Wetted Perim (ft)	= 20.95
Crit Depth, Yc (ft)	= 0.89
Top Width (ft)	= 20.32
EGL (ft)	= 1.49



Appendix F

AutoDesk Hydraflow Express Output:

100-year/24-hour Storm Event

Channel Report

Channel 1 (100-Yr)

Trapezoidal

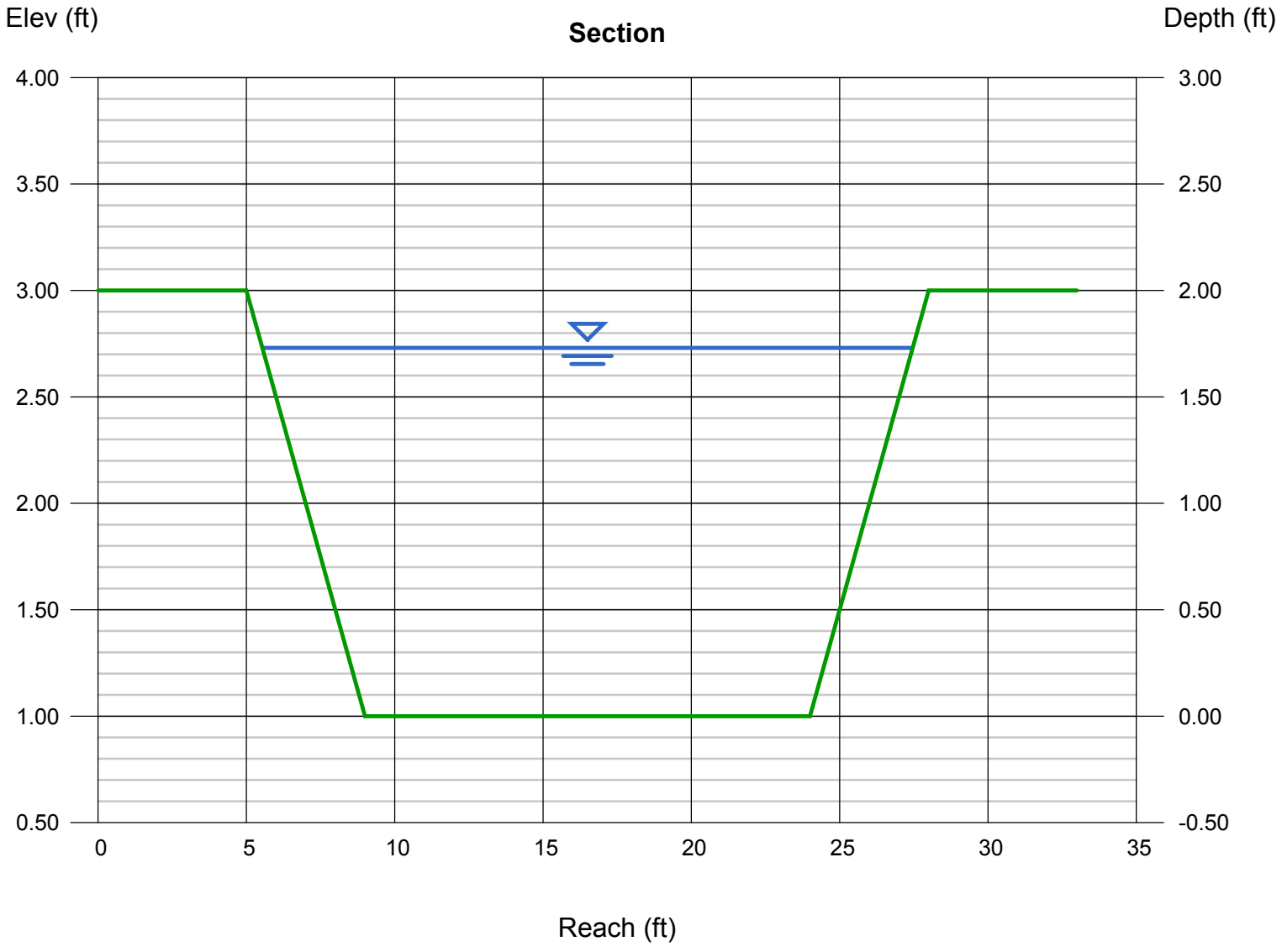
Bottom Width (ft)	= 15.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.20
N-Value	= 0.022

Calculations

Compute by:	Known Q
Known Q (cfs)	= 119.98

Highlighted

Depth (ft)	= 1.73
Q (cfs)	= 119.98
Area (sqft)	= 31.94
Velocity (ft/s)	= 3.76
Wetted Perim (ft)	= 22.74
Crit Depth, Yc (ft)	= 1.19
Top Width (ft)	= 21.92
EGL (ft)	= 1.95



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Mar 22 2016

Channel 2 (100-Yr)

Trapezoidal

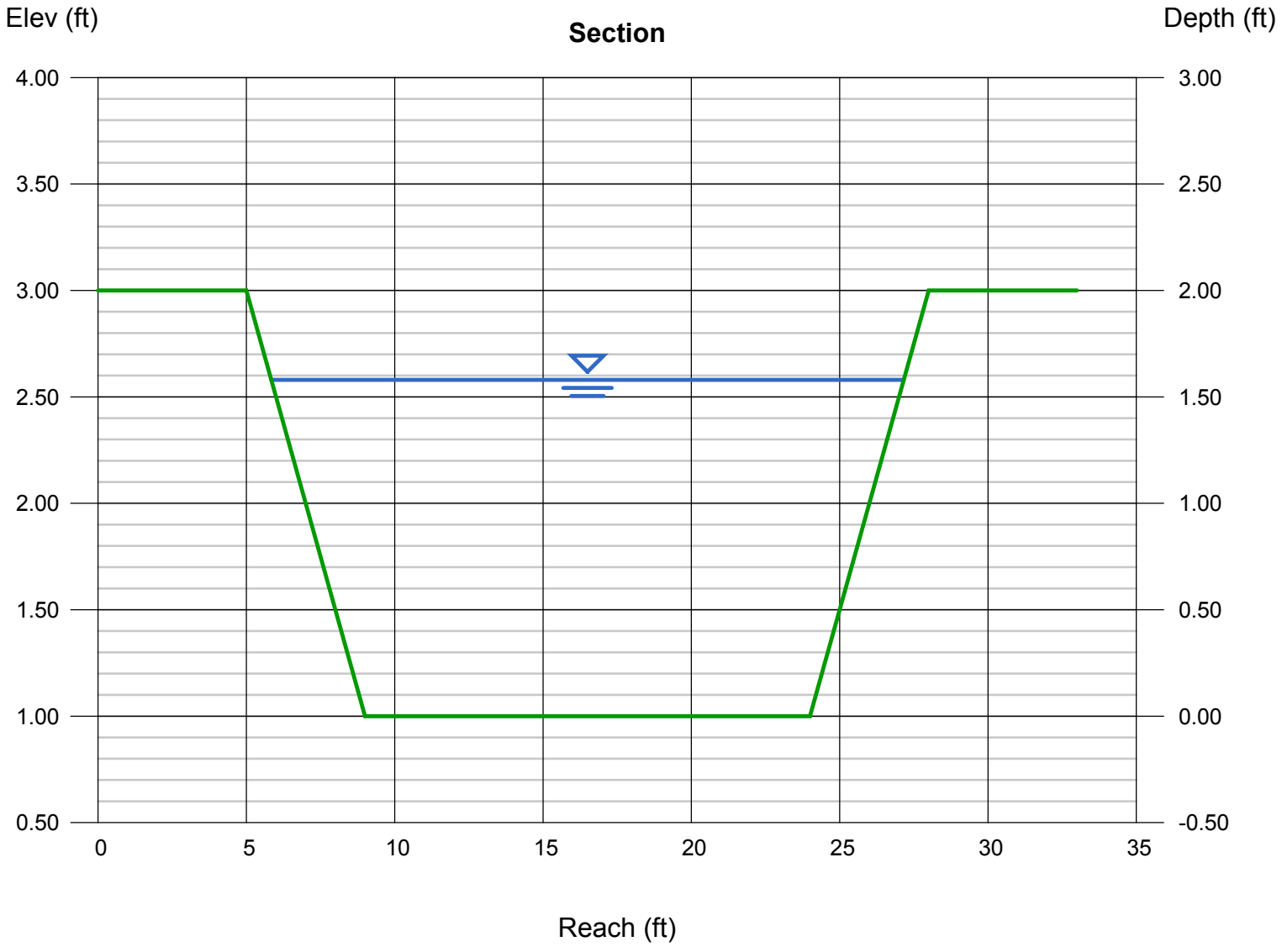
Bottom Width (ft)	= 15.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.20
N-Value	= 0.022

Calculations

Compute by:	Known Q
Known Q (cfs)	= 102.40

Highlighted

Depth (ft)	= 1.58
Q (cfs)	= 102.40
Area (sqft)	= 28.69
Velocity (ft/s)	= 3.57
Wetted Perim (ft)	= 22.07
Crit Depth, Yc (ft)	= 1.08
Top Width (ft)	= 21.32
EGL (ft)	= 1.78



Channel Report

Channel 3 (100-Yr)

Trapezoidal

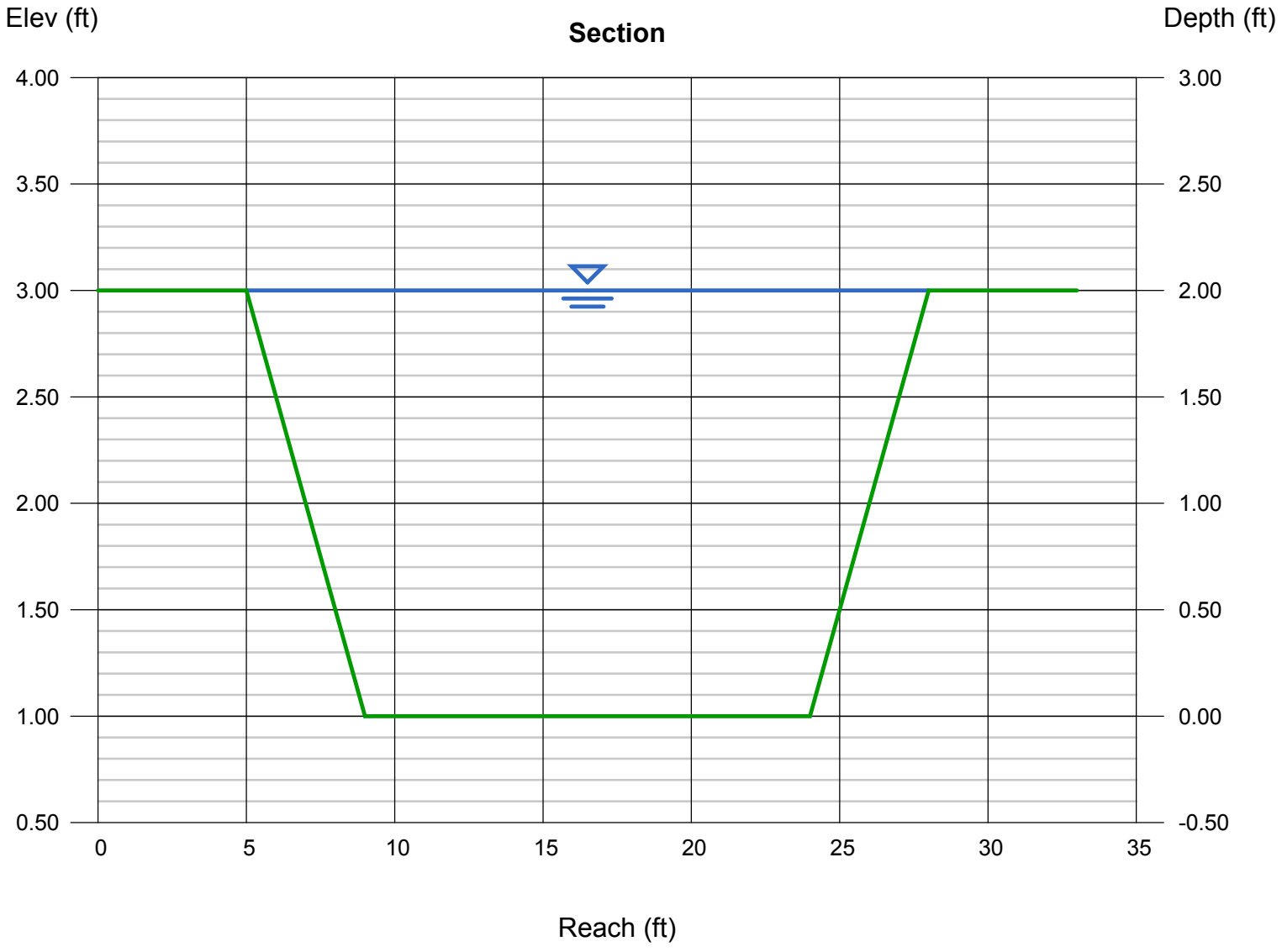
Bottom Width (ft)	= 15.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.20
N-Value	= 0.022

Calculations

Compute by:	Known Q
Known Q (cfs)	= 154.89

Highlighted

Depth (ft)	= 2.00
Q (cfs)	= 154.89
Area (sqft)	= 38.00
Velocity (ft/s)	= 4.08
Wetted Perim (ft)	= 23.94
Crit Depth, Yc (ft)	= 1.40
Top Width (ft)	= 23.00
EGL (ft)	= 2.26



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Mar 22 2016

Channel 4 (100-Yr)

Trapezoidal

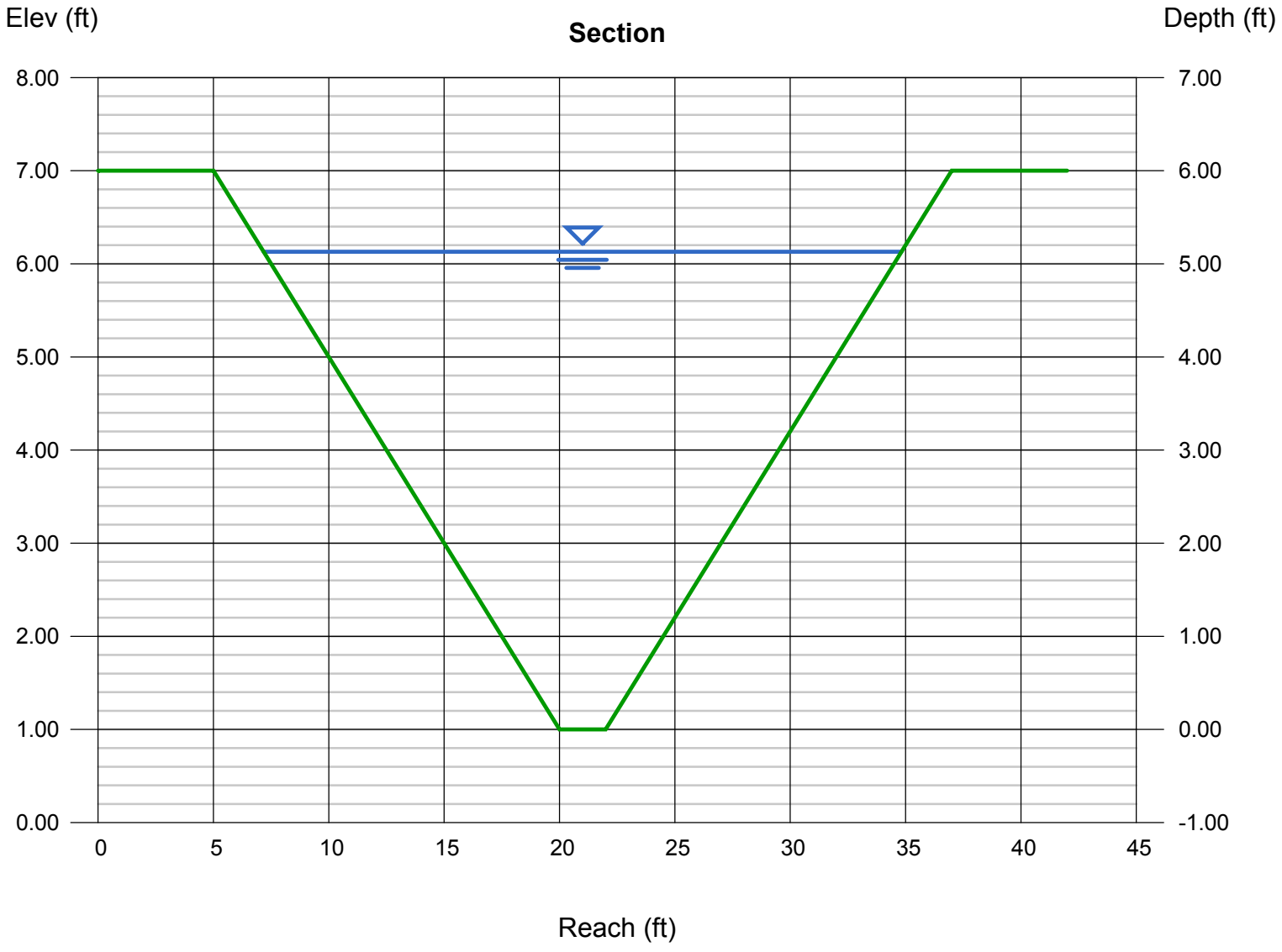
Bottom Width (ft)	= 2.00
Side Slopes (z:1)	= 2.50, 2.50
Total Depth (ft)	= 6.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.10
N-Value	= 0.022

Calculations

Compute by:	Known Q
Known Q (cfs)	= 303.25

Highlighted

Depth (ft)	= 5.13
Q (cfs)	= 303.25
Area (sqft)	= 76.05
Velocity (ft/s)	= 3.99
Wetted Perim (ft)	= 29.63
Crit Depth, Yc (ft)	= 3.54
Top Width (ft)	= 27.65
EGL (ft)	= 5.38



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Mar 22 2016

Channel 5 (100-Yr)

Trapezoidal

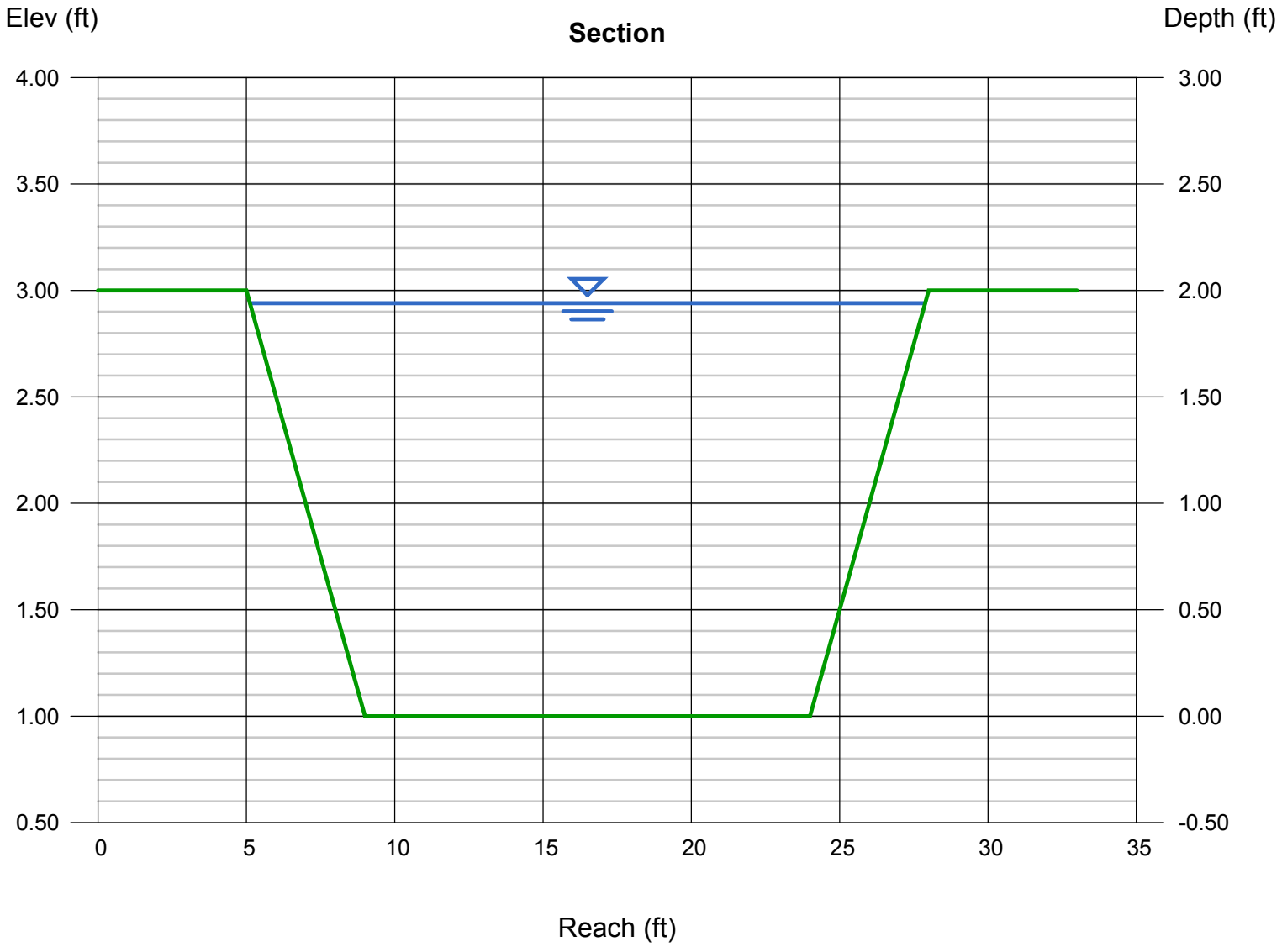
Bottom Width (ft)	= 15.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.20
N-Value	= 0.022

Calculations

Compute by:	Known Q
Known Q (cfs)	= 146.85

Highlighted

Depth (ft)	= 1.94
Q (cfs)	= 146.85
Area (sqft)	= 36.63
Velocity (ft/s)	= 4.01
Wetted Perim (ft)	= 23.68
Crit Depth, Yc (ft)	= 1.36
Top Width (ft)	= 22.76
EGL (ft)	= 2.19



Channel Report

Channel 6 (100-Yr)

Trapezoidal

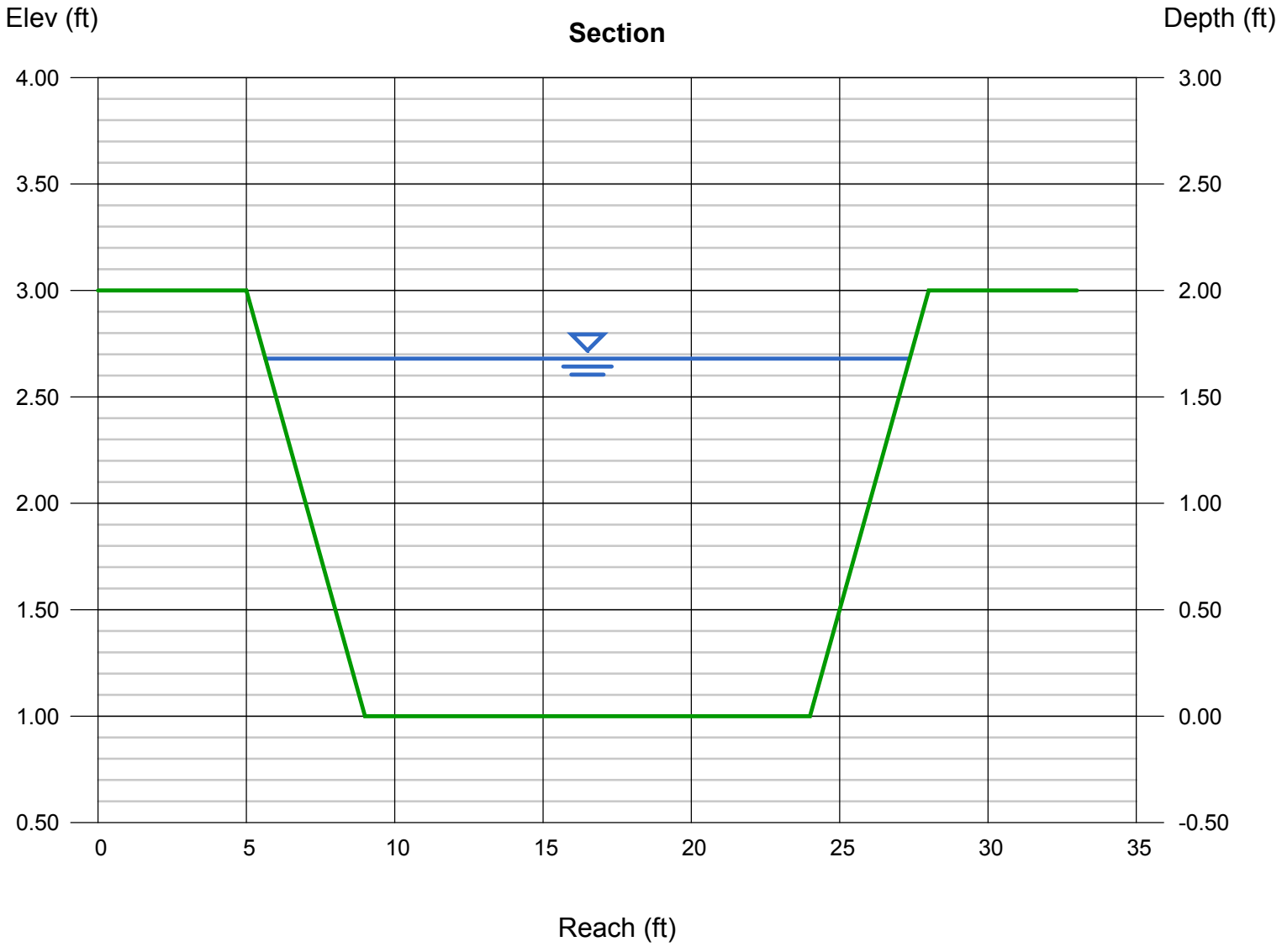
Bottom Width (ft)	= 15.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.20
N-Value	= 0.022

Calculations

Compute by:	Known Q
Known Q (cfs)	= 113.99

Highlighted

Depth (ft)	= 1.68
Q (cfs)	= 113.99
Area (sqft)	= 30.84
Velocity (ft/s)	= 3.70
Wetted Perim (ft)	= 22.51
Crit Depth, Yc (ft)	= 1.16
Top Width (ft)	= 21.72
EGL (ft)	= 1.89



Appendix G

North American Green
ECMDS Output

Tensar International Corporation
5401 St. Wendel-Cynthiana Road
Poseyville, Indiana 47633
Tel. 800.772.2040
Fax 812.867.0247
www.nagreen.com

Erosion Control Materials Design Software
Version 5.0

Project Name: Old American Zinc Site
Project Number: 89504
Channel Name: Channels 1,2,3,5, and 6

Discharge	102.64
Peak Flow Period	24
Channel Slope	0.002
Channel Bottom Width	15
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	C
Vegtation Type	Bunch Type
Vegetation Density	Good 75-95%
Soil Type	Silt Loam

DS75

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
DS75 Unvegetated	Straight	102.64 cfs	3.16 ft/s	1.75 ft	0.027	1.55 lbs/ft2	0.22 lbs/ft2	7.08	STABLE	D

Unreinforced Vegetation - Class C - Bunch Type - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
Unreinforced Vegetation	Straight	102.64 cfs	2.03 ft/s	2.52 ft	0.051	4.2 lbs/ft2	0.31 lbs/ft2	13.36	STABLE	--
Underlying Substrate	Straight	102.64 cfs	2.03 ft/s	2.52 ft	--	0.04 lbs/ft2	0.015 lbs/ft2	2.33	STABLE	--

Tensar International Corporation
5401 St. Wendel-Cynthiana Road
Poseyville, Indiana 47633
Tel. 800.772.2040
Fax 812.867.0247
www.nagreen.com

Erosion Control Materials Design Software
Version 5.0

Project Name: Old American Zinc Site
Project Number: 89504
Channel Name: Channel 4

Discharge	191.13
Peak Flow Period	24
Channel Slope	0.001
Channel Bottom Width	2
Left Side Slope	2.5
Right Side Slope	2.5
Low Flow Liner	
Retardance Class	C
Vegtation Type	Bunch Type
Vegetation Density	Good 75-95%
Soil Type	Silt Loam

DS75

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
DS75 Unvegetated	Straight	191.13 cfs	3.69 ft/s	4.17 ft	0.021	1.55 lbs/ft2	0.26 lbs/ft2	5.96	STABLE	D

Unreinforced Vegetation - Class C - Bunch Type - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
Unreinforced Vegetation	Straight	191.13 cfs	2.09 ft/s	5.66 ft	0.045	4.2 lbs/ft2	0.35 lbs/ft2	11.9	STABLE	--
Underlying Substrate	Straight	191.13 cfs	2.09 ft/s	5.66 ft	--	0.04 lbs/ft2	0.021 lbs/ft2	1.63	STABLE	--

ARCADIS

Sheet _1__ of __4_ Date: 03/23/16

Project # HA100254.0000

Computed by: ZAC

Project Old American Zinc Plant Site Checked by: JWH

Subject Revised Universal Soil Loss Calculation Approved by:

REVISED UNIVERSAL SOIL LOSS CALCULATION

1.0 OBJECTIVE:

Estimate the average annual rate of soil loss from the landscape profile due to sheet and rill erosion using the Revised Universal Soil Loss Equation (RUSLE).

2.0 GIVEN

1. The slope of the landscape profile is 33.33H:1V.

2. The maximum slope length is approximately 600 feet.

3.0 ASSUMPTIONS

1. A Crop-Management Factor of 0.01 is representative of a meadow with a cover of grass-and-legume mix and a moderate productivity level. (Ref 1)

2. The primary soil type used for the cover is Shaffton-Urban Land Complex. There is no published K-Value for this soil complex. The most conservative K-Value for the RUSLE equation is 0.65, which will be used for this analysis. (Ref 2 and 3)

3. Assume a Support Practice Factor of 1. (Ref 1)

4. Assume an R-Value of 200 for Fairmont City, Illinois. (Ref 3 - See R-Values Figure)

4.0 CALCULATIONS

The Revised Universal Soil Loss Equation:

$$A = R * K * LS * C * P$$

Where:

A = Estimated Average Soil Loss (tons/acre/year)

R = Rainfall-Runoff Erosivity Factor

K = Soil Erodibility Factor

LS = Topographic Factor, which is a function of Slope Length and Slope Steepness

C = Crop-Management Factor

P = Support Practice Factor

Use Table LS-3 to determine the LS-Value for the maximum slope length (600 feet). Use linear interpolation for horizontal slope lengths that are between values. The slope is 33.33H:1V (or 3%).

Maximum Slope Length LS-Value = 0.96

Apply the Revised Universal Soil Loss Equation to estimate the average annual soil loss for the maximum slope length (600 feet).

$$A = R * K * LS * C * P$$

$$A = 200 * 0.65 * 0.96 * 0.01 * 1$$

A = 1.25 tons/acre/year

1.25 tons/acre/year < 5 tons/acre/year **OK**

5.0 REFERENCES

1. Hydraulic Analysis and Design by Richard H. McCuen, Third Edition, Pearson Education, Inc., 2005, Upper Saddle River, New Jersey.

2. USDA Web Soil Survey.

3. USDA, Revised Universal Soil Loss Equation 1.06 – Bulletins.

TABLE 15–4 Generalized Values of the Cover and Management Factor, *C*, in the 37 States East of the Rocky Mountains[a]

		Productivity Level[b]	
		High	Mod.
Line no.	Crop, Rotation, and Management[c,d]	C Value	
Base value: continuous fallow, tilled up and down slope		1.00	1.00
CORN			
1	C, RdR, fall TP, conv (1)	0.54	0.62
2	C, RdR, spring TP, conv (1)	0.50	0.59
3	C, RdL, fall TP, conv (1)	0.42	0.52
4	C, RdR, wc seeding, spring TP, conv (1)	0.40	0.49
5	C, RdL, standing, spring TP, conv (1)	0.38	0.48
6	C, fall shred stalks, spring TP, conv (1)	0.35	0.44
7	C(silage)-W(RdL, fall TP) (2)	0.31	0.35
8	C, RdL, fall chisel, spring disk, 40–30% rc(1)	0.24	0.30
9	C(silage), W wc seeding, no-till pl in c-k W(1)	0.20	0.24
10	C(RdL)-W(RdL, spring, TP) (2)	0.20	0.28
11	C, fall shred stalks, chisel pl, 40–30% rc (1)	0.19	0.26
12	C-C-C-W-M, RdL, TP for C, disk for W (5)	0.17	0.23
13	C, RdL, strip till row zones, 55–40% rc (1)	0.16	0.24
14	C-C-C-W-M-M, RdL, TP for C, disk for W (6)	0.14	0.20
15	C-C-W-M, RdL, TP for C, disk for W (4)	0.12	0.17
16	C, fall shred, no-till pl, 70–50% rc (1)	0.11	0.18
17	C-C-W-M-M, RdL, TP for C, disk for W (5)	0.087	0.14
18	C-C-C-W-M, RdL, no-till pl 2d & 3rd C (5)	0.076	0.13
19	C-C-W-M, RdL, no-till pl 2d C (4)	0.068	0.11
20	C, no-till pl in c-k wheat, 90–70% rc (1)	0.062	0.14
21	C-C-C-W-M-M, no till pl 2d & 3rd C (6)	0.061	0.11
22	C-W-M, RdL, TP for C, disk for W (3)	0.055	0.095
23	C-C-W-M-M, RdL, no-till pl 2d C (5)	0.051	0.094
24	C-W-M-M, RdL, TP for C, disk for W (4)	0.039	0.074
25	C-W-M-M-M, RdL, TP for C, disk for W (5)	0.032	0.061
26	C, no-till pl in c-k sod, 95–80% rc (1)	0.017	0.053
COTTON[f]			
27	Cot, conv (Western Plains) (1)	0.42	0.49
28	Cot, conv (South) (1)	0.34	0.40
MEADOW			
29	Grass and legume mix	0.004	0.01
30	Alfalfa, lespedeza, or Sericia	0.020	
31	Sweet clover	0.025	
SORGHUM, GRAIN (Western Plains)[g]			
32	RdL, spring TP, conv (1)	0.43	0.53
33	No-till pl in shredded 70–50% rc	0.11	0.18
SOYBEANS[f]			
34	B, RdL, spring TP, conv (1)	0.48	0.54
35	C-B, TP annually, conv (2)	0.43	0.51
36	B, no-till pl	0.22	0.28
37	C-B, no-till pl, fall shred C stalks (2)	0.18	0.22

TABLE 15–5 Values of Support-Practice Factor, P

	Land Slope (%)				
	1.1–2	2.1–7	7.1–12	12.1–18	18.1–24
Practice	Factor P				
Contouring, P_c	0.60	0.50	0.60	0.80	0.90
Contour strip cropping,[a] P_{sc}					
R-R-M-M	0.30	0.25	0.30	0.40	0.45
R-W-M-M	0.30	0.25	0.30	0.40	0.45
R-R-W-M	0.45	0.38	0.45	0.60	0.68
R-W	0.52	0.44	0.52	0.70	0.90
R-O	0.60	0.50	0.60	0.80	0.90
Contour listing or ridge planting, P_{cl}	0.30	0.25	0.30	0.40	0.45
Contour terracing,[b,c] P_t	$0.6/\sqrt{n}$	$0.5/\sqrt{n}$	$0.6/\sqrt{n}$	$0.8/\sqrt{n}$	$0.9/\sqrt{n}$
No support practice	1.0	1.0	1.0	1.0	1.0

[a]R, rowcrop; W, fall-seeded grain; O, spring-seeded grain; M, meadow. The crops are grown in rotation and so arranged on the field that rowcrop strips are always separated by a meadow or winter-grain strip.

[b]These P_t values estimate the amount of soil eroded to the terrace channels and are used for conservation planning. For prediction of off-field sediment, the P_t values are multiplied by 0.2.

[c]n, number of approximately equal-length intervals into which the field slope is divided by the terraces. Tillage operations must be parallel to the terraces.

slope of 2.5%, Table 15–5 indicates a support-practice factor of 0.5 when the field is contoured. This would reduce the unit erosion to 1.5 tons/acre/yr, or 2.95 tons/yr for the 2-acre plot. Thus contouring reduced gross erosion by 50%.

15.5.2 Other Empirical Equations

Other equations exist for estimating volumes or rates of soil loss, with many of them being similar to the USLE. The Musgrave Equation is

$$E = F\left(\frac{R}{100}\right)\left(\frac{S}{10}\right)^{1.35}\left(\frac{L}{72.6}\right)^{0.35}\left(\frac{P_{30}}{1.25}\right)^{1.75} \tag{15–15}$$

in which E is the probable soil loss (tons/ac/yr), F is a soil erodibility factor, R is a cover factor, S is the slope (%), L is the length (ft), and P_{30} is the 2-yr, 30-min rainfall intensity (in./30 min). Several differences between Musgrave's Equation and the USLE are obvious. First, the Musgrave Equation is nonlinear. The exponents reflect the data that were used to calibrate Equation 15–15. Data from nineteen research stations, with 5 to 15 years of data collected at each station, were used in calibration. Second, the Musgrave Equation uses the slope and length directly rather than as an input to the topographic factor of the USLE.

Beer, Farnham, and Heinemann (1966) provided the following equation, which is based on an empirical analysis of data from western Iowa:

$$E = 0.392 \times 10^{-6} KPRR_c S^{1.35} L^{0.35} \tag{15–16}$$

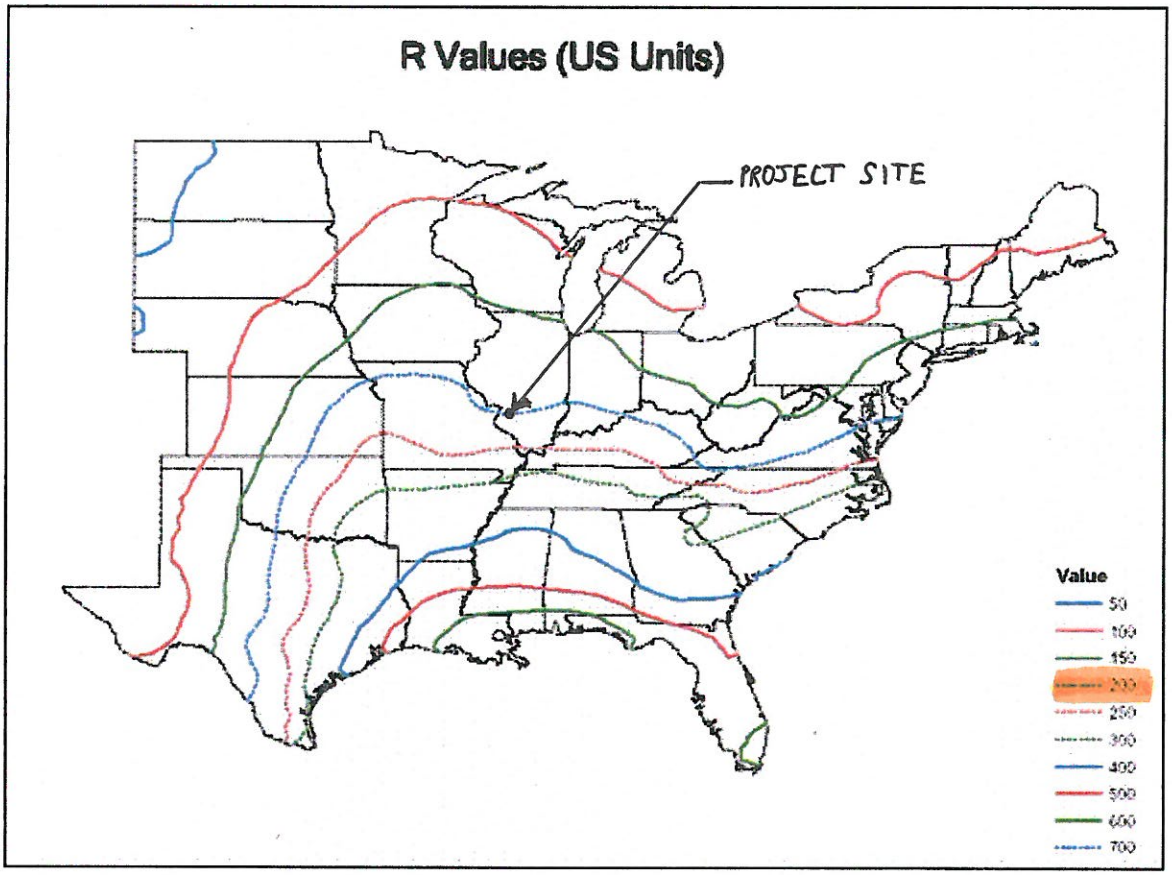

R Values (US Units)
PROJECT SITE
Value
50
100
150
200
250
300
400
500
600
700

TABLE LS - 3

CONSTRUCTION AND MINING SITES

High Ratio of Rill to Interrill Erosion [1/]

Slope (%)	Horizontal slope length (ft)									
	25	50	75	100	150	200	250	300	400	600
0.2	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06
0.5	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.12
1.0	0.10	0.13	0.14	0.15	0.17	0.18	0.19	0.20	0.22	0.24
2.0	0.16	0.21	0.25	0.28	0.33	0.37	0.40	0.43	0.48	0.56
3.0	0.21	0.30	0.36	0.41	0.50	0.57	0.64	0.69	0.80	0.96
4.0	0.26	0.38	0.47	0.55	0.68	0.79	0.89	0.98	1.14	1.42
5.0	0.31	0.46	0.58	0.68	0.86	1.02	1.16	1.28	1.51	1.91
6.0	0.36	0.54	0.69	0.82	1.05	1.25	1.43	1.60	1.90	2.43
8.0	0.45	0.70	0.91	1.10	1.43	1.72	1.99	2.24	2.70	3.52
10.0	0.57	0.91	1.20	1.46	1.92	2.34	2.72	3.09	3.75	4.95
12.0	0.71	1.15	1.54	1.88	2.51	3.07	3.60	4.09	5.01	6.67
14.0	0.85	1.40	1.87	2.31	3.09	3.81	4.48	5.11	6.30	8.45
16.0	0.98	1.64	2.21	2.73	3.68	4.56	5.37	6.15	7.60	10.26
20.0	1.24	2.10	2.86	3.57	4.85	6.04	7.16	8.23	10.24	13.94
25.0	1.56	2.67	3.67	4.59	6.30	7.88	9.38	10.81	13.53	18.57
30.0	1.86	3.22	4.44	5.58	7.70	9.67	11.55	13.35	16.77	23.14
40.0	2.41	4.24	5.89	7.44	10.35	13.07	15.67	18.17	22.95	31.89
50.0	2.91	5.16	7.20	9.13	12.75	16.16	19.42	22.57	28.60	39.95
60.0	3.36	5.97	8.37	10.63	14.89	18.92	22.78	26.51	33.67	47.18

[1/] Such as for freshly prepared construction and other highly disturbed soil condition.

ARCADIS

Sheet _1__ of __2_ Date: 03/23/16

Project # HA100254.0000

Computed by: JWH

Project Old American Zinc Plant Site Checked by: ZAC

Subject Consolidataion Area Slope Stability Calculation Approved by:

CONSOLIDATION AREA SLOPE STABILITY CALCULATION

ARCADIS

Sheet _2__ of __2_ Date: 03/23/16

Project # HA100254.0000

Computed by: JWH

Project Old American Zinc Plant Site Checked by: ZAC

Subject Consolidataion Area Slope Stability Calculation Approved by: _____

1.0 OBJECTIVE:

Perform a slope stability calculation for the Consolidation Area to estimate the Factor of Safety against slope failure.

2.0 GIVEN

1. Maximum final slope height = 5 feet.

2. Steepest Final Slope : 4H:1V.

3.0 ASSUMPTIONS

1. Materials placed in the consolidation area will be primarily soils or soil-like and will be compacted during placement.

2. A shear strength of c=0, phi = 23° is a reasonably conservative estimate of the shear strength of the material placed in the Consolidation Area.

4.0 CALCULATIONS

Given the short slope height and moderate maximum slope proposed for the consolidation area, an Infinite Slope analysis is sufficient for demonstrating an adequate factor of safety against slope failure. A more rigorous approach would yield a higher factor of safety.

Infinite Slope Calculation:

$$FS = \tan(phi) / Tan(B)$$

Where:

FS = Factor of Safety against slope failure

phi = friction angle of the material in the Consolidation Area

B = The angle of the final Consolidation Area Slope (4H:1V = 14°)

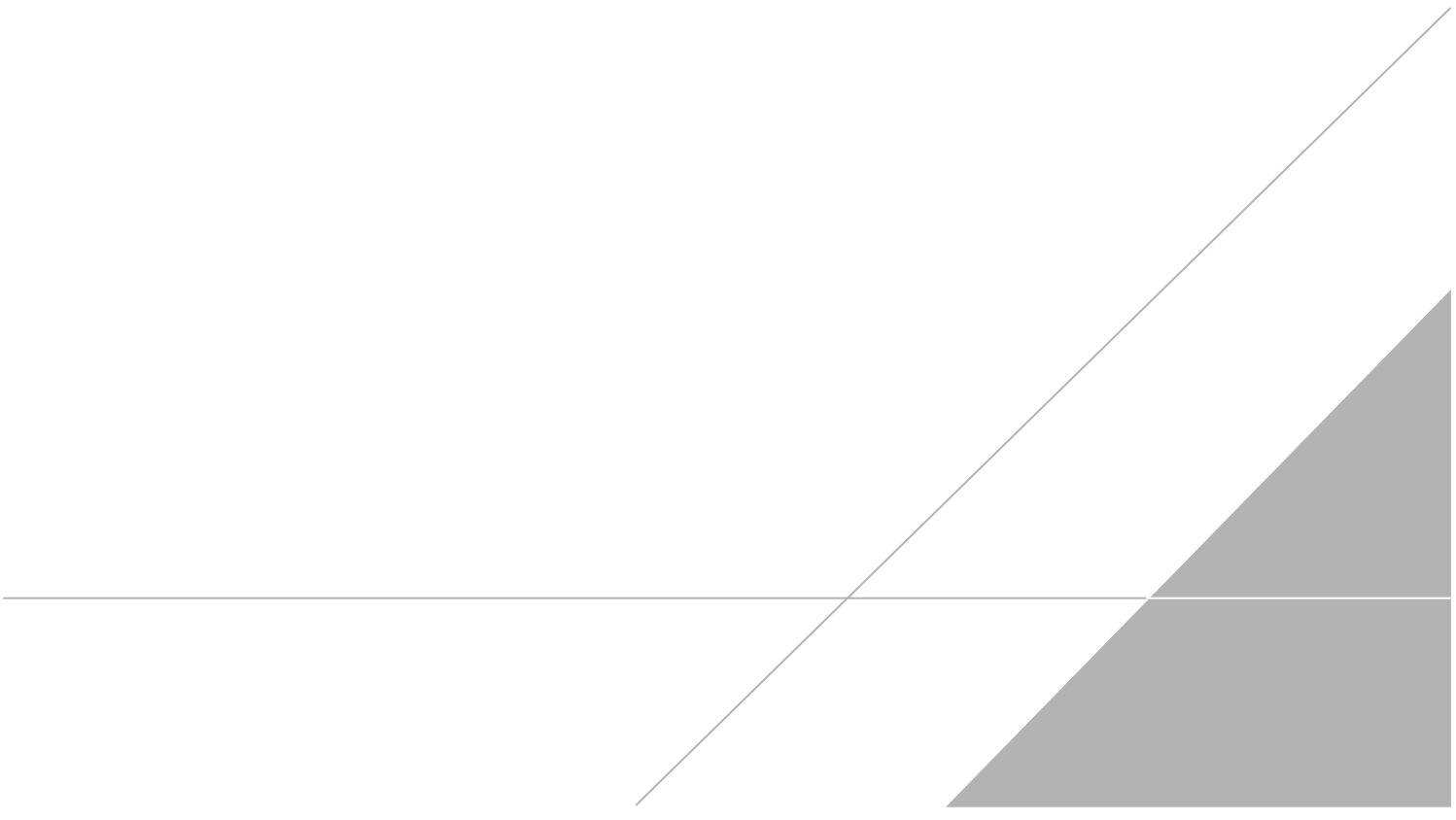
FS = tan(23°) / tan(14°)

FS = 1.7

1.7 > 1.5 **OK**

APPENDIX C

Outlines for Supporting Documents



RA WORK PLAN OUTLINE

1.0 INTRODUCTION
- 1.1 Scope and Purpose
- 1.2 Site Description
- 1.3 Remedial Design Elements

2.0 EXCAVATION PLANS
- 2.1 Erosion and Sediment Control
- 2.2 Facility Area Excavation
  - 2.2.1 Source Materials
    - 2.2.1.1 Excavation Methods
    - 2.2.1.2 Depths
    - 2.2.1.3 Confirmation Sampling
  - 2.2.2 Consolidation Area Over-Excavation
    - 2.2.2.1 Area and Depths
    - 2.2.2.2 Stockpiling
    - 2.2.2.3 Prequalification Sampling for Capping
  - 2.2.3 Rose Creek and East Ditch
    - 2.2.3.1 Extent of Remediation
    - 2.2.3.2 Excavation Methods
  - 2.2.4 West Ditch Outfall
    - 2.2.4.1 Extent of Remediation
    - 2.2.4.2 Excavation Methods
  - 2.2.5 Existing Soil Stockpile
    - 2.2.5.1 Segregating Usable Materials (As Consolidation Area Cover)
    - 2.2.5.2 Prequalification Sampling (For use as Consolidation Area Cover)
- 2.3 Residential and Commercial Properties
  - 2.3.1 Properties to be Remediated
    - 2.3.1.1 Locations
    - 2.3.1.2 Excavation Depths and Confirmation Sampling
    - 2.3.1.3 Prequalification Testing for use as Consolidation Area Cover
  - 2.3.2 Alleyways
    - 2.3.2.1 Location of Segments to be Remediated
    - 2.3.2.2 Excavation Depths and Confirmation Sampling

3.0 Consolidation Area Construction
- 3.1 Staged Excavation and Filling
- 3.2 Fill Placement and Compaction
  - 3.2.1 Placement and Compaction
  - 3.2.2 Construction Quality Assurance
- 3.3 Fencing

4.0 Restoration
- 4.1 Consolidation Area Capping
  - 4.1.1 Material Requirements
  - 4.1.2 Construction Techniques
  - 4.1.3 Final Cover Seeding

- 4.1.4 Construction Quality Assurance
- 4.2 Facility Area Regrading and Restoration
  - 4.2.1 Grading and Construction Techniques
  - 4.2.2 Final Surface Preparation
  - 4.2.3 Seeding
  - 4.2.4 Ditch Lining
  - 4.2.5 Construction Quality Assurance
- 4.3 Residential and Commercial Properties
  - 4.3.1 Material Requirements
  - 4.3.2 Construction Techniques
  - 4.3.3 Final Surface Preparation
  - 4.3.4 Seeding
  - 4.3.5 Construction Quality Assurance
- 4.4 Alleyway Restoration
  - 4.4.1 Material Requirements
  - 4.4.2 Construction techniques
  - 4.4.3 Final Surface Preparation
  - 4.4.4 Construction Quality Assurance
- 4.5 Rose Creek and East Ditch
  - 4.5.1 Material Requirements
  - 4.5.2 Construction Techniques
  - 4.5.3 Final Surface Preparation
  - 4.5.4 Construction Quality Assurance

5.0 Institutional Controls
- 5.1 Vacant and Commercial Properties
- 5.2 Consolidation Area
- 5.3 Groundwater

6.0 Operation and Maintenance
- 6.1 Overview, reference Appendix H.

APPENDICIES

A. Construction Drawings
B. Health and Safety Plan
C. Performance Verification Plan
D. Erosion and Sediment Control Plan

HEALTH AND SAFETY PLAN OUTLINE

1. Emergency Contact Information and Procedures

   Directions to Hospital

2. Introduction

3. Project Site History and Requirements

   3.1 Site Background

   3.2 Site Description

   3.3 List of Project Tasks and Scope of Work

4. Remedial Action Contractor Organization and Responsibilities

   4.1 All Personnel

   4.2 Project Manager/Task Manager

   4.3 Site Safety Officer (SSO)

5. Project Hazards and Control Measures

   5.1 Hazard Analysis

   5.2 Job Safety Analyses (JSAs), H&S Standards and PPE

   5.3 Field Health & Safety Handbook

6. Hazard Communication (HazCom)

7. Tailgate Meetings

8. Medical Surveillance

9. General Site Access and Control

   9.1 Sanitation at Temporary Workplaces

      9.1.1 Potable Water

      9.1.2 Toilet Facilities

Tables

Appendices

PERFORMANCE STANDARD VERIFICATION PLAN OUTLINE

1.0 INTRODUCTION
- 1.1 Scope and Purpose
- 1.2 Site Description
- 1.3 Remedial Design Elements

2.0 SHORT TERM PERFORMANCE STANDARDS
- 2.1 Excavation Verification
  - 2.1.1 Field Sampling Plan and QAPP
    - 2.1.1.1 Facility Area Source Removal
    - 2.1.1.2 Sediment Removal
    - 2.1.1.3 Residential and Commercial Properties Excavation
    - 2.1.1.4 West Ditch Outlet Excavation
    - 2.1.1.5 Documentation, Reporting and Record Keeping
- 2.2 Consolidation Area Construction
  - 2.2.1 CQA Plan
    - 2.2.1.1 Verification of Placement and Compaction
    - 2.2.1.2 Verification of Final Grades
    - 2.2.1.3 Capping
    - 2.2.1.4 Documentation, Reporting and Record Keeping
- 2.3 Site Restoration
  - 2.3.1 CQA Plan
    - 2.3.1.1 Regrading of Non-Consolidation Area Portion of Facility Area
    - 2.3.1.2 Backfilling of Off-Facility Properties
    - 2.3.1.3 Backfilling of Alleyways
    - 2.3.1.4 Fencing Around Consolidation Area
    - 2.3.1.5 Establishing Vegetative Cover
    - 2.3.1.6 Documentation, Reporting and Record Keeping
- 2.4 Institutional Controls
  - 2.4.1 Institutional Control Implementation and Assurance Plan
    - 2.4.1.1 Facility Area Groundwater Use Restriction
    - 2.4.1.2 Consolidation Area Deed Restriction
    - 2.4.1.3 Commercial and Vacant Lot Deed Restrictions
    - 2.4.1.4 Documentation, Reporting and Record Keeping

3.0 LONG TERM PERFORMANCE STANDARDS
- 3.1 Consolidation Area O&M
  - 3.1.1 Operational and Maintenance
  - 3.1.2 Documentation and Record Keeping
- 3.2 Groundwater Monitoring Plan
- 3.3 Surface Water Monitoring Plan

APPENDICIES

A. Quality Assurance Project Plan
B. Field Sampling Plan
C. Construction Quality Assurance Plan

D. Institutional Controls Implementation and Assurance Plan
E. Operation and Maintenance Plan

QUALITY ASSURANCE PROJECT PLAN OUTLINE

Appendices

A	Lab Certifications
B	Test America QC
C	Laboratory Quality Manual
D	CoC, Custody Seal, Sample Label Example

FIELD SAMPLING PLAN OUTLINE

List of Acronyms/Abbreviations

1. Project Description

- 1.1 Purpose and Objectives
- 1.2 Site Description and Background
  - 1.2.1 Site Location
  - 1.2.2 Site Features
  - 1.2.3 Ownership and Operational History
    - 1.2.3.1 Former American Zinc, Lead & Smelting Company
    - 1.2.3.2 XTRA Intermodal, Inc.
- 1.3 Environmental Setting
  - 1.3.1 Climate and Air Quality
  - 1.3.2 Geology and Hydrogeology
  - 1.3.3 Drainage and Hydrology
    - 1.3.3.1 On-Site Ditches
    - 1.3.3.2 Rose Creek
    - 1.3.3.3 Schoenberger Creek
    - 1.3.3.4 Old Cahokia Watershed
  - 1.3.4 Ecological Setting
    - 1.3.4.1 Surrounding Wetlands
    - 1.3.4.2 Threatened and Endangered Species
    - 1.3.4.3 Ecological Survey
- 1.4 Regulatory Status

2. Previous Investigations and Historical Records

- 2.1 Time-Critical Removal Action
- 2.2 Remedial Investigation
- 2.3 Pre-Design Investigation

3. Proposed Sampling Strategy

- 3.1 Nature and Distribution of Contamination
  - 3.1.1 Heavy Metals

Tables

Figures

Appendices

CONSTRUCTION QUALITY ASSURANCE PLAN OUTLINE

INSTITUTIONAL CONTROL IMPLEMENTATION AND ASSURANCE PLAN OUTLINE

1.0 INTRODUCTION
- 1.1 Entity that Prepared the ICIAP
- 1.2 Name and Location of Site Requiring ICs (including any site aliases)
- 1.3 Agency Responsible for IC Oversight

2.0 SITE DETAILS
- 2.1 Site Description
  - 2.1.1 Site Identification
  - 2.1.2 Location
  - 2.1.3 Site Area and Affected Resources
- 2.2 Brief Site History
  - 2.2.1 Previous Site Uses
  - 2.2.2 Contaminants of Concern (COCs)
  - 2.2.3 Risk Exposure Pathways
  - 2.2.4 Response Action Summary
  - 2.2.5 Cleanup Objectives
  - 2.2.6 Substantive Use Restrictions Identified in the Decision Document(s) (i.e., IC objectives)
  - 2.2.7 Current and Reasonably Anticipated Future Land Use
- 2.3 Property Information and Stakeholder Contacts
  - 2.3.1 Parcel Ownership/Occupancy Information
  - 2.3.2 Property Interest and Resource Ownership
  - 2.3.3 Responsible Parties and Other Stakeholders
  - 2.3.4 Tribal, State, and/or Local Government Contacts
  - 2.3.5 Other Relevant Stakeholders
- 2.4 Location of Residual Contamination, IC Boundaries, and Other Site Features
  - 2.4.1 Location of Contamination
  - 2.4.2 Location of Impacted Parcels
  - 2.4.3 Location of Engineering Controls
  - 2.4.4 Location of Restricted Areas
  - 2.4.5 Other Relevant Features

3.0 KEY ELEMENTS FOR ALL PLANNED/IMPLEMENTED ICS
- 3.1 General Elements
  - 3.1.1 Instrument Name
  - 3.1.2 Instrument Type
  - 3.1.3 Entity Responsible for Implementation
  - 3.1.4 Implementation Event and Date
  - 3.1.5 Substantive Use Restrictions Achieved by this IC
  - 3.1.6 Legal Description of Restricted Area(s)
  - 3.1.7 IC Instrument Lifespan
  - 3.1.8 Potential Barriers to IC Implementation
- 3.2 Elements Specific to Instrument Category
  - 3.2.1 Proprietary Controls
  - 3.2.2 Governmental Controls

OPERATION AND MAINTENANCE PLAN OUTLINE

1.0 INTRODUCTION
- 1.1 Scope and Purpose
- 1.2 Site Description
- 1.3 Remedial Design Elements

2.0 OPERATIONAL AND MAINTENANCE REQUIREMENTS
- 2.1 Inspections
  - 2.1.1 Cap System
  - 2.1.2 Fence
  - 2.1.3 Drainage Channels
  - 2.1.4 Groundwater Monitoring Wells
- 2.2 Maintenance
  - 2.2.1 Cap System
    - 2.2.1.1 Mowing
    - 2.2.1.2 Erosion Repair
    - 2.2.1.3 Re-Seeding
  - 2.2.2 Fence
  - 2.2.3 Ditches
    - 2.2.3.1 Erosion Repair
    - 2.2.3.2 Bank Stabilization
  - 2.2.4 Groundwater Monitoring Wells
    - 2.2.4.1 Pads
    - 2.2.4.2 Protective Casing and Bollards
    - 2.2.4.3 Redevelopment

APPENDIX D

Responses to Comments on the Preliminary Design

U.S. Environmental Protection Agency (U.S. EPA) comments on the Preliminary Design Report. Responses to comments are included in *italic*.

General Comments

1. Provide list of proposed specifications, and a complete list of proposed drawings.

   A list of proposed specifications is included in the Construction Quality Assurance Plan Outline provided in Appendix C of the DFRD Report. The proposed final drawings are listed in the DFRD Table of Contents. The proposed final drawings are presented in Appendix A of the DFRD.

Specific Comments

1. **Section 1.1, 6th Bulle**t: Please provide the following drawings:

   - Individual drawings for each of the impacted off-site properties, including structures, utilities, excavation depths, and restoration.

     As per discussion with Ms. Sheila Desai on 2/2/106, a figure (Drawing 6 in Appendix A) has been included in the Draft Final Design showing the outlines of the properties that require remediation. The table presented on that drawing describes the portion of each property to be remediated. A typical (not to scale) detail showing a typical residential/commercial property excavation has been included as Detail 7 on Drawing 9 in Appendix A of the DFRD. Detail 3 on Drawing 9 in Appendix A of the DFRD illustrates the proposed excavation and restoration of the alleyways.

     Private utilities will be marked during the removal actions, and will be included in subsequent drawings.

   - Removal areas and depths within Rose Creek, access points and restoration details.

     The extent of removal of sediments in Rose Creek and East Ditch are shown on Drawing 4 in Appendix A of the DFRD. At this time, based on the dimensions and slope of Rose Creek and the East Ditch, it is anticipated that excavation and restoration

can be completed using a long-stick excavator sitting at the top of the bank. If it becomes necessary to enter either the creek or the ditch to affect the remediation, the means and methods to do so will be developed by the Remedial Action Contractor for approval by the Owner.

The proposed excavation depth is one foot. Detail 4 on Drawing 9 in Appendix A of the DFRD illustrates the proposed depth of excavation.

- Restoration details for the proposed and existing ditches.

  The restoration of the remediated ditches includes simply replacing excavated soil with clean soil or gravel. The restoration is included on Detail 4 on Drawing 9 in Appendix A of the DFRD.

- Excavation and restoration details for the outfall(s).

  Based on the RI/FS, ROD and discussions with USEPA, Rose Creek Outfall is not designated for remediation, and only the portion of the West Ditch Outfall represented by sample SD-33-0.5 will be remediated. The location is shown on Drawing 6 in Appendix A of the DFRD. A conceptual detail of this remediation is presented on Detail 6 on Drawing 9 in Appendix A of the DFRD.

Please provide the following calculations:

- Volume calculations for all excavations and required import/borrow, including facility area, offsite properties, ditches, outfalls, and drainage ways.

  These calculations are presented in Appendix B of the DFRD and discussed in Section 4.3.6.1 of the DFRD.

- Stormwater calculations for existing ditches and Rose Creek.

  Storm Water Calculations including ditches and Rose Creek, are discussed in Section 6.3.6.2 and included in Appendix B of the DFRD.

- Soil erosion calculations for consolidation area.

  Soil Erosion Calculations for the consolidation area are discussed in Section 6.3.6.4 and included in Appendix B of the DFRD.

- Calculations estimating infiltration through the consolidation cap, and justify whether a leachate collection system is needed or not needed.

  Modeling of infiltration completed as part of the FS demonstrated that the proposed cap would be effective in adequately limiting infiltration.

- Slope stability calculations for critical sections of the consolidation cell.

  Slope Stability Calculations for the consolidation area are discussed in Section 6.3.6.5 and included in Appendix B of the DFRD.

2. **Section 4.3.3**: The text implies new ditches will be 5 feet, however, Drawing 7 shoes ditches to be 15 feet wide and the Stormwater calculations are performed for a ditch that was 15 feet wide. Please clarify. Additionally, drawings show a new 15 foot wide ditch which discharges into a 9 foot wide ditch (no calculation provided), and then into Rose Creek (no calculation provided), is this correct?

   The ditches will be 15 feet wide, as indicated on the drawings and as per the calculations. The drawings correctly show the new 15 foot wide ditch discharging into a narrower east ditch, which discharges into Rose Creek. The 15 foot wide ditches were designed to limit the flow depth in these ditches on the main part of the property. The east ditch is deeper than the 15 foot wide ditches, and will accommodate the flow without issue. This has been verified by the storm water calculations presented in Appendix B of the DFRD.

3. **Section 4.3.11**: Heading jumps from 3rd level to 5th level. Instead of generally suggesting ARARs will be met, list each ARAR and specifically detail how the RD will meet it.

The heading format has been noted.
The identification of Applicable or Relevant and Appropriate Regulations (ARARs) and how the Remedial Design (RD) will meet it has been discussed in previously submitted documents, including the Feasibility Study (FS) and ROD.

4. **Figure 4**: The base layers should be legible. If not feasible, label Kingshighway, I-55, Old Cahokia Creek and any other relevant points on the map. Recommend changing the color of Kingshighway to a color other than red (same color as alleyways requiring soil removal). The scale of the various layers should be consistent (the background layer has a different scale shown in the lower left hand corner than what is in the legend). Explain what the asterisk after note 2 means.

   A new base map has been developed. Figure 4 is now more clear.

5. **Appendix A, Drawing 1**: Facility Area Existing Conditions: The word "residential" is misspelled in the stockpile label.

   The misspelling of "residential" has been corrected.

6. **Appendix A, Drawing 4**: Confirm that borings used actually extend to the bottom of the source material, and show the bottom of the source material, not just the bottom of the boring. Example, SB-17-SW did not extend through the source material, and was terminated in the source material, but data is being used to represent the source material bottom.

   Soil boring data has been verified. Notes have been added to the design drawings in the DFRD to indicate that the excavation/bottom of source material grades are approximate and will be adjusted based on the actual depth of source material encountered..

7. **Appendix A, Drawing 6**: On the left side, extend cap down to meet clay surface (see figure below).

   This change has been reflected in the Draft Final Design.

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